

U. S. Circuit Court. Southern District of
New York

American Graphophone Company)	In Equity
versus)	No. 7063
National Gramophone Company)	
and Frank Seaman)	

COMPLAINANT'S PROOFS FOR FINAL HEARING, 1899

Raymond R. Wile
1976.

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Electrostatic copies of
originals introduced in
American Graphophone Co.
versus Berliner Gramophone
Co. -- Archives Section --
FRC -- Philadelphia (RG21)

0-17

IN THE CIRCUIT COURT OF THE UNITED STATES
FOR THE SOUTHERN DISTRICT OF NEW YORK.

AMERICAN GRAPHOPHONE COMPANY	:	#7063
	:	
VS.	:	IN EQUITY.
	:	
NATIONAL GRAMOPHONE COMPANY	:	
and FRANK SEAMAN	:	
	:	

PROOFS FOR FINAL HEARING taken on behalf of Complainant under the provisions of the 67th Rule in Equity, pursuant to agreement, before Reeve Lewis, a Notary Public in and for the District of Columbia, acting herein as Special Examiner by consent, at the offices of ~~Ruhlar~~ Philip Mauro, Esq., No. 620 F. Street, N.W., Washington, D.C., beginning March 27th., 1899, at 11 A.M.

PRESENT:

Philip Mauro, Esq., for Complainant,

Gustav Bissing, Esq., and Horace Pettit, Esq. for Defendants.

Complainant's counsel offers in evidence Patent Office copies of the following letters patent, to wit:

(1) No. 341, 214, to C.A. Bell and S. Tainter, dated May 4th., 1886, to be marked "Complainant's Exhibit Patent No. 341, 213, in Suit",

(2) No. 341, 288, to S. Tainter, dated May 4th., 1886 to be marked "Complainant's Exhibit Patent No. 241, 288, in Suit".

(3) Patent No. 375, 579, to S. Tainter, dated December 27, 1887, to be marked "Complainant's Exhibit Patent No. 375, 579, in Suit".

And also offers for identification a machine to be mark-

ed "Complainant's Exhibit Defendants' Machine for Identification", and

A sound record to be marked "Complainant's Exhibit Defendants' Sound Record for Identification".

AND THEREUPON, Shelton T. Cameron, a witness produced on behalf of Complainant, being first duly sworn and cautioned to tell the truth, the whole truth and nothing but the truth, deposes and says:

Q.1 Please state your name, age, residence and occupation.

A. Shelton T. Cameron; 41 years of age; residence Washington, D.C; Occupation, solicitor of patents and expert in patent causes.

Q.2. State briefly what experience you have had in examining patented and other structures, and comparing the same for the purpose of determining questions of identity and dissimilarity, and generally your experience as an expert in patent causes ?

A. As a youth I was greatly interested in mathematics and mechanics and spent much time in workshops and manufactories studying the construction and operation of mechanical structures and in my mature years I have continued such studies visiting in the line of my profession numerous establishments where different mechanical devices were in active operation. For more than eight years I was an assistant examiner in the United States Patent Office where it was a part of my daily duty to study devices for which patents were sought to compare the same with the state of the art as disclosed in domestic and foreign patents, as well as in printed publications, and to report upon the same.

In the practice of my profession I have prepared and prosecuted numerous applications for patents and have been repeatedly called upon to testify as an expert before the U.S. Courts in patent causes.

Q.3. Are you familiar with the art of recording and reproducing sounds, as practically carried on, and with the literature of that art, and if so, please state how much familiarity was acquired.

A. I am quite familiar with the art referred to, not only as the same is practically carried on, but as such art is disclosed in patented and unpatented structures and in the literature relating thereto. Since entering upon the practice of my profession I have prepared and prosecuted numerous applications relating directly or indirectly to this art, and have repeatedly given expert affidavits and testified as a mechanical expert in causes before the U.S. Courts for alleged infringements of talking machine patents. I have repeatedly testified as expert witness in causes in which the Bell and Tainter Patent No.341,214 and the Tainter Patent No.341,288 here in suit have been involved. I have already given expert affidavit in this cause in connection with the motion by complainant for a preliminary injunction.

Q.4. Have you read and do you understand the invention set forth in Complainant's Exhibit Patent No.341.214 in suit ?

A. I have read and understand the patent referred to.

Q.5. What improvements and invention, in view of the prior art, do you find described and claimed in said patent having reference particularly to the reproducing devices ?

A. The invention set forth in patent No.341,214 consists

of a method of and apparatus for recording and reproducing speech and other sounds. The art of recording and reproducing acoustical vibrations necessarily consists of two distinct operations, viz: first, the recording of the acoustical vibrations; second, the reproduction from the record obtained by the operation of vibrations similar to the original or recorded ones. The first of these operations, i.e. the recording of sound waves, was a familiar one to scientists for many years before it was discovered how to perform the second or reproducing operation. As early as 1857 one Leon Scott devised an instrument subsequently known as the "Scott Phonautograph" which produced a visual record of sound-waves.

Scott's phonautograph record was obtained by coating a tablet with lamp-black and allowing a style carried by a suitable diaphragm to rest against the tablet while the latter was revolved and at the same time given a rectilinear motion past the style.

In the absence of sound the style traced a regular spiral line of even depth in the lamp-black on the surface of the tablet, but when sound waves were caused to impinge upon the diaphragm the spiral line traced by the style in the lamp-black became an irregular ~~x~~ zig-zag of sinuous line even depth, the sinuosities of which were in a plane parallel with the surface of the tablet and corresponded in form to the sound waves impinging upon the diaphragm. This gave a visual record of the acoustical vibrations, but there was no known way to reproduce sounds therefrom.

By Alexander Graham Bell's invention of the speaking

telephone, it was clearly demonstrated that if a diaphragm was caused to vibrate by or in accordance with sound-waves, and a second diaphragm were mechanically caused to copy or vibrate in imitation of the vibrations of the first diaphragm vibrating would be reproduced by the second. This suggested the possibility of securing a record of the vibrations of the first diaphragm in material of sufficient solidity to be utilized in imparting vibrations to the second diaphragm, and in this suggestion the art of recording and reproducing sounds had its birth. The inventors, one a Frenchman named Charles Cros, and another an American, Thomas A. Edison, nearly simultaneously invented means by which this suggestion could be carried into effect. As the invention of Cros was a carrying forward or elaboration of the Scott Phonautograph I will describe it first.

On April 30th., 1877, Mr. Cros deposited with the French Academy of Science a description of his method in which he said:

"Process of Recording and Reproducing Audible Phenomena. In general my process consists in obtaining the tracing of the to and fro movements of a vibrating membrane, and the utilization of this tracing for reproducing the same to-and-fro movements, with their relative inherent durations and intensities in the same membrane, or in another adapted for furnishing the sounds and noises which result from this series of movements.

We are, therefore, concerned with the transformation of an extremely delicate tracing, such as that obtained with a delicate stylus rubbing upon a surface blackened by a flame, to transform, I say, these tracing in relief or in intaglio in resisting material, capable of guiding a moving body which transmits these movements to the sonorous membrane.

A light stylus is connected with the centre of a vibrating membrane; it terminates in a point (metallic wire, the barb of a feather, etc.), which bears upon a surface blackened by a flame. This surface is a part of a ~~disk~~ disk to which is given a double movement or rotation and rectilinear progression.

If the membrane is at rest, the point will trace a

simple spiral; if the membrane vibrates, the traced spiral will be undulating and these undulations represent exactly all the to-and-fro movements of the membrane with their times and intensities."

It will be seen that this is in effect a Scott phonautograph, and Mr. Cross then proceeds to describe how he secures from this tracing in lamp black his record in resisting material.

He says:

"By means of the photographic process, which, in fact, is well known, this traced, transparent, undulatory spiral is converted into a line of similar dimensions, in intaglio or in relief in resisting material like tempered steel, for instance.

This done, this resisting surface is, by means of a motor apparatus, made to turn and to progress rectilinearly with a velocity like that which was used in the registration.

If the reproduced tracing is in intaglio, a metallic point (and if it is relief, a notched finger), held by a spring, bears upon the tracing at one end and is connected at the other end with the centre of the membrane adapted for sound reproduction. Under these conditions, this membrane is not only more acted upon by the vibrating air, but by the tracing controlling the pointed stylus by pulsations exactly like those to which the membrane was subjected in recording, both as to duration and intensity. The spiral trace represents in successive equal periods by its increasing and decreasing length. There is nothing inconvenient in this if only the outer portion of the rotating circular is used, and if the spirals are close together except that the central part of the disk is lost.

In all cases, however, a helical tracing upon a cylinder is much to be preferred, and I am actually engaged in finding a practical embodiment of this."

May___ 1878 Cross took out a French patent No. 124,213, in which he said, speaking of different kinds or forms of sound records which might be made.

"The question is of registering by a continuous tracing the vibrations of a diaphragm.

I see three kinds of tracings; a transversely undulating tracing; a tracing undulated in depth; a simple lineal tracing, straight or rectilinear which I will call the straight tracing.

x x x x x x x x

The tracing undulating in depth is that which Mr. Edison adopted, after having abandoned diverse projects based on the straight tracing. This tracing

requires a notable force of the stylus on a yielding substance.

Tin foil gave the first results. Despite the reducing advantage of the immediate reperirion, despite the facility and simplicity of its use, I do not believe in the future of tin foil in phonography. However, tin foil has been proposed and used with success for the first time by Mr. Edison.

It will be seen further on that I obtain the immediate repetition by another process which gives moreover the facility of indefinite repetition.

The transversely undulating tracing is that which I proposed first. Obtained by lamp black deposited upon the surface of glass or smooth paper, it is that which requires the least force.

Consequently it will give more details, more fineness in the results, since it opposes the slightest resistance to the small vibrations, which are also the weakest ones.

It is this process which will give in my opinion serious and complete results."

After explaining one method which he follows for obtaining a record in solid material from this transversely undulating or zig-zag tracing in lamp black, Cross proceeds to indicate a method of etching a zig-zag record in metal by the use of acids. He says:

"The lamp-black may be replaced by a body insulating an underlying metallic plate from the engraving action of an acid. In this case the work of the stylus is increased by the cohesion of the insulating substance. Tallow, parafine, the varnish of aquae fortis can serve."

That is, he can take a tablet of metal and instead of lamp-black coat it with tallow or parafine or other substance resisting the action of acids, and then get his zig-zag tracing in this coating just as the Scott Phonautograph did in the lamp-black, after which acid is applied to eat out the metal along the line of the tracing. Briefly stated then, Cross disclosed in 1877 and 1878 a method of producing a record of sound-waves in solid resisting material by photo-engraving, the phonautographic record of such sound waves having first been produced as an undulatory line of even depth in a traveling laver of non-resisting material.

such as lamp-black; and he also disclosed a method of producing a phonautographic record through a film of suitable etching ground deposited upon a traveling surface of resisting material, such as metal, and then subjecting such surface to the action of an etching agent, such as an acid which attacked said surface only at the places where the etching ground had been removed by the recording stylus. This record described by the Cross patent of 1878 was a transversely undulating zig-zag-or sinuous groove of even depth, through it is evident from the quotations which I have made that Cross understood that there was a record groove with vertical undulations, for he says; "I see x x the tracing undulated in depth." This record with vertical undulations was the form adopted ~~Mr. Kx~~ by Mr. Edison in his tin foil phonograph of 1878. Edison took a tablet having a spiral groove cut thereon and covered it with tin foil. A style attached to a diaphragm was supported with its point resting on the tin foil immediately over the spiral groove. In this case the vibrations of the style were not parallel to the surface of the tablet, as in Scott's phonautograph and Cross's etched zig-zag record, but were perpendicular thereto, and when the tablet was revolved and given rectilinear motion past the diaphragm and style, sound waves impinging upon the diaphragm vibrated towards and from the tablet surface, and caused the style to indent the tin foil over the spiral groove formed in the tablet and thereby trace an undulatory spiral line in the tin foil, the undulations being perpendicular to the surface of the cylinder and corresponding to the sound waves impinging upon the

upon the diaphragm. It thus appears that as early as 1878 there were two well known forms of sound records, viz: the zig-zag record of even depth, as in the Cross etched or photoengraved record; and the one of uneven depth with vertical undulations, as in the Edison tin-foil record.

To reproduce sound from Cross's zig-zag record, whether the same were etched or produced by the photoengraving process, it would be necessary to adjust a style attached to a diaphragm in the record groove and give the tablet the rotation and the rectilinear movement it had when forming the record. The style would rest in the groove whose undulatory or zig-zag side walls would cause the style to vibrate from side to side thus causing the diaphragm to copy the vibrations of the recording diaphragm and thereby reproduce the recorded sounds.

To reproduce sound from the Edison indented tin-foil record having vertical undulations, it was necessary to carefully adjust the style of the reproducing diaphragm in the indented groove, and upon rotating the record tablet and giving it rectilinear movement, as was done in forming the record, the indentations in the tin foil would cause the style and its attached diaphragm to vibrate towards and from the tablet and copy in an imperfect way the vibrations of the recording diaphragm.

In forming a sound record by either of the above methods it was immaterial whether the tablet was a disk or a cylinder as in either case the record would be produced in the form of a spiral groove on the surface of the tablet.

While both Cross and Edison describe the means by the use of which it was possible to record and reproduce sound, the Edison phonograph amounted to nothing more than a scientific toy by which the theory of sound reproduction might be demonstrated and so far as I am aware Cross never actually constructed the device described in his French patent. It appears that Edison succeeded in actually obtaining reproductions of sound from his phonograph, but it was found impossible to use this tin foil phonograph in practical affairs for the intelligible reproduction of speech. Edison's reproducer was adjusted by the exercise of great care and skill into proper relation with the indented record and then clamped rigidly in position. As the groove of the record is an exceedingly fine, thread-like line this adjustment is very difficult to secure and even when such adjustment was successfully accomplished, it was by no means certain that the proper relation between the style and record would be maintained. Inaccuracies in the construction of the machine, so minute in character that it is mechanically impossible to avoid them, would throw the record groove out of alignment with the style, or would cause the groove to approach too close to or recede too far from the point of the style.

For example, if the record tablet was a flat disk, any departure of the surface from a true plane, as by warping, even to the extent of a thousandth part of an inch, would cause the record to fail entirely to contact with the style, or else to bear upon it with such force as to iron out or deform the undulations. In fact the finer and more delicate undulations were ironed out, even with the most accurate

adjustments obtainable, while the larger undulations were so distorted that they no longer constituted even an approximate record of the original sounds. Of course when the style thus in the act of ironing out an undulation, the latter was not causing the reproducing diaphragm to correctly copy the vibrations of the original or recording diaphragm, and consequently the original sounds were not reproduced even the first time the record was used. I might add that the adjustment necessary to secure the proper contact between the style and the undulations or indentations was necessarily so accurate that variations of temperature alone were sufficient to throw Edison's rigidly clamped reproducer out of adjustment so that records made at one temperature could not be reproduced at another temperature.

By the method described in their patent No. 341,214 in suit, Bell and Tainter ~~em~~ cut or engraved an undulating record in a tablet of wax or wax-like material by means of a cutting style having its point imbedded in the tablet surface, and attached to a vibratory diaphragm upon which sounds to be recorded were allowed to impinge. The tablet of wax or wax-like material is soft enough to enable the cutting or engraving style, when actuated by a force so weak as that of a sound wave to readily cut the undulatory groove therein, and is at the same time sufficiently solid to enable the undulations of the sound groove to actuate the rubbing style of the reproducing diaphragm without being themselves ironed out or distorted. The cutting action of the recording style is not that of a knife edge which merely enters the material and crowds it to one side, but is a true engraving action, whereby a portion of the tablet is removed in the form of

chips or shaving to the form the sound groove.. The patent says that the essential new features of the invention is the removal of the material to form the record by a cutting, gouging or engraving action of the vibrating style. Wax or a wax-like composition was found to be peculiarly adapted for this purpose and the patent very clearly points out the conditions which controlled in the selection of this as a material for the tablet. On page 1 of this specification, lines 59 to 65, the inventor says:

"The invention consists, secondly, in engraving or cutting the record in a waxy or amorphous and slightly cohesive substance, preferably, a compound of bees wax and paraffine (the latter in excess) is employed. This compound has no tendency to clog the style, but is readily removed thereby in chips or shavings."

As I have before stated, the record groove is an exceedingly delicate, thread-like line, frequently not more than one, one thousandth of an inch in depth, and in order to guide the point of the reproducing style in this shallow groove, Bell and Tainter formed their groove with sloping walls, and then loosely mounted the reproducing style so that it can be readily guided by the record. The patent states this so clearly between the lines 76 and 83 page 1, that I cannot do better than quote therefrom. It says:-

"The invention consists, thirdly, in cutting or engraving a record in the form of a groove with sloping walls, sound waves being represented by elevations and depressions at the bottom of the groove, or otherwise. The advantage of this form of record is that it forms an efficient guide to the reproducing style."

That this part of the Bell and Tainter invention is not limited to a vertically undulatory groove, or to a groove formed in a tablet of wax or wax-like material, is

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clearly shown by the cause just quoted. So long as the record is cut or engraved "in the form of a groove with sloping walls", it is immaterial whether the sound waves are represented therein by "elevations and depressions at the bottom of the groove" or are represented "otherwise" than by such elevations and depressions, as for example, by lateral undulations such as the zig-zag groove of the Cross etched record.

The essential requirements of this part of the invention is that the record shall be cut or engraved in the form of a groove with sloping walls and the particular advantage being that this groove with sloping walls "forms an efficient guide to the reproducing style." As a means of enabling the reproducing style to be guided by the record, Bell and Tainter conceived the very ingenious idea of loosely mounting the style so that it was free to turn and adjust itself to and follow the record. The patent says, line 84, page 1, to line 3, page 2:

"The invention consists, fourthly, in loosely mounting the reproducing style so that it can be readily guided by the record; preferably the reproducing style, or rather what may be called the 'head' of the reproducing instrument, is mounted on a universal joint, and the style is pressed against the record by the yielding pressure of a spring or weight. Practically in instruments made by us, the pressure is due to the weight of the instrument, modified by the elasticity of a section of soft rubber tube, which supports the same and constitutes a universal joint; but evidently there are many devices which can be used to mount the reproducer, so that it is free to follow the sound record, or phonogram, and which, therefore, would be within the scope of the invention.

The reproducing style, mounted as just explained, is specially adapted for use in connection with a record in the form of a groove with sloping walls, and this combination is specially claimed; but it may also be usefully employed in connection with other forms of record."

From what has heretofore been said it will be understood that all sound-records have two sorts of irregularities, viz: the undulations representing sound waves and those irregularities due to the impossibility of constructing machinery which shall be mathematically and theoretically true in every respect. Examples of this latter class of irregularity are found in a cylindrical record that is not a true cylinder, a disk record that is warped from a true plane, and a spiral groove that is not a true spiral. Many others will readily suggest themselves. These irregularities of the second class, while minute, are very great as compared with those representing sound waves. It is necessary that the diaphragm of the reproducer should vibrate in response to irregularities of the first sort, and that it should not vibrate at all in response to the irregularities of the second sort.

The reproducing diaphragm is mounted or supported in a frame or head, and this frame or head ~~xxx~~ must remain stationary in respect to the irregularities of the first sort (or those representing sound waves) but must respond perfectly to irregularities of the second sort or those due to inaccuracies of construction or variations in different mechanics in cases where the record is made on one machine and reproduced on another. This was a very difficult and unusual problem, but Bell and Tainter solved it by mounting the reproducer (that is the head with its supported diaphragm and style) on a universal joint and applying a yielding pressure in the form of a suitable spring or weight to the style to hold the same against the record.

This yielding pressure may be secured and commonly is, by forming the reproducer head of such mass as to enable it to readily yield to the irregularities of construction, and at the same time possess an inertia so great that to the minute irregularities of the sound groove, it is immobile, thereby enabling all movements due to the latter form of irregularities to be impressed upon the diaphragm.

In the particular construction described in Patent No. 341,214 in suit, the weight is modified by the elasticity of a section of soft rubber tubing, thereby utilizing the combined action of a spring and weight. This section of rubber tubing also performs another exceedingly useful function, viz: it constitutes a universal joint by means of which the loose mounting of the reproducer is not only to enable it to adjust itself to the irregularities of construction, which I have just mentioned, but is also for the purpose of enabling the reproducer to be guided and moved by the record.

After describing the construction and mode of mounting the reproducer the patent says, on page 4, lines 68 - 84:

"There exists always a liability to disarrangement in some part of the machine, either in the recorder or in the support therefor, or the recording tablet or its support, or if there be no disarrangement, it would be difficult to insure that the reproducing style should touch the record precisely at the proper point if the reproducer be held rigidly. Difficulties on these accounts are avoided by the loose or flexible mounting of the reproducer, the style automatically adjusting itself to the proper place on the record. It will be seen that the reproducer is mounted on a universal joint, so that it can move in any direction. The movement parallel with the face of the tablet would, however, by itself allow the style to follow and adjust itself to the record to a useful extent."

As is pointed out in the paragraph of the specification, which I have heretofore quoted, this loosely mounted reproduc-

er is specially effective when used in connection with a record groove having sloping walls, because this form of groove is an efficient guide to carry the reproducing style along over the record. But Bell and Tainter were well aware that there were "other forms of record" (such as the Cross etched zig-zag record for example) which might usefully be employed to guide the reproducer across the record, as said reproducer turned on its universal joint, and they therefore pointed out that their invention or the universally-jointed or loosely mounted reproducer is not limited or confined in its employment to any particular form of record.

Another feature of improvement in the construction of the reproducer is accomplished by allowing the style to project beyond the edge of the supporting frame or head. Prior to the date of the Bell and Tainter invention, the diaphragm had been stretched across the frame or head as the diaphragm is on a drum, and the style was connected to the center of the diaphragm and projected therefrom at right angles to the plane thereof. The necessary result of this was when the reproducer was placed with the style on the record, the style was covered by the diaphragm and head and its position could not be seen, thereby rendering it difficult to adjust it to any desired position on the record. To obviate this Bell and Tainter formed "a reproducer or reproducing instrument in which the reproducing style, instead of being placed behind its support, projects at the point beyond the edge thereof." Besides allowing the position of the style to be observed this construction of reproducer with the style projecting from its edge is particularly useful in

reproducing from that class of record which, like the Cross etched record has lateral or zig-zag undulations.

When reproducing from such record the diaphragm is placed in a plane perpendicular to the plane of the record and consequently in order to enable the reproducing style to enter the record groove, it must project from the edge ^{or} of the frame head. Two forms of Bell and Tainter's ~~patent~~ reproducer with its projecting style are shown in Figs. 8 to 10 of the patent No. 341,214 in suit. The style 26 is clamped, rivited or cemented to the diaphragm 23 of Fig. 8, or 38 of Fig. 9 and it has its end projecting to enter the sound groove.

Adjourned by consent to Tuesday March 28th., 1899,
at 10'30 A. M.

Washington, D.C.,

March 28th., 1899.

Met pursuant to adjournment.

Present:

Parties as before.

Mr. Cameron continues his answer to question 5.

A further important improvement described in the patent is the mounting of the recorder so that it is held with yielding pressure against the surface of the tablet. As stated in lines 30 to 50, of page 2 of the specification this consists:

"in a sound recorder having a cutting or graving style which is held by elastic or yielding pressure against the surface on which the record is to be made. The object is to enable the vibratory graver or cutting style to ride over instead of ploughing through any elevations on the recording surface. The depth to which the point of the cutting style is embedded in the record affects the amplitude of the styles vibration. By this improvement the depth is kept uniform notwithstanding any slight unevenness of the recording surface."

By the construction here described provision is made by means of which the recorder is enabled to perform its functions without being affected by the irregularities such as the unevenness of the recording surface to which I have referred in connection with the reproducer. One method of securing this yielding action of the recorder or reproducer is to have the recorder or reproducer, as the case may be, rest against the tablet by gravity. this action of the recording style in cutting or engraving a record groove is controlled entirely by the force of the sound waves impinging upon the diaphragm of the re-

corder, and since the resistance to the cutting action increases very rapidly with any increase in the depth of the cut, the action of the style would meet an undue and in fact a fatal resistance to recording action if it were allowed to plough through any uneven portions of the record.

For example, if a cylindrical tablet were slightly eccentric, say even to the one thousandths part of an inch or if the action of temperature upon the material of the tablet was such as to cause it to expand unevenly though but in the slightest degree, and if the recorder were clamped or otherwise held rigidly in position, it will be perceived that the groove cut by the style in the cylinder would offer a varying resistance to the action of the style and that in portions of the cylinder the style would have imposed upon it a much greater amount of work to perform than the feeble power of the sound waves would be able to accomplish.

This being the case it will be readily understood that the successful cutting of a sound record depended upon the discovery of some means whereby the resistance to cutting action of the style might be rendered uniform, and as a matter of fact I understand that it was not until the idea of the gravity controlled or floating recorder and reproducer had been advanced that Bell and Tainter carried the idea of forming an engraved (?) to a successful conclusion, notwithstanding the fact that they had experimented with a cut or engraved record prior to the invention of the yielding or gravity controlled recorder or reproducer. This construction has become known in the art as the "floating" or

"gravity" recorder or reproducer. The term "floating" is a peculiarly apt one in this connection as the recorder or reproducer, as the case may be, rises and falls upon the surface of the record just as a block of wood rises and falls upon the surface of the water, the block conforming at all times to the varying plane of the surface of the water while remaining always in contact therewith. The result of this floating action of the recorder or reproducer is that any unevenness in the surface of the record will not affect the perfect operation of either the recorder in making the sound groove, or the reproducer when in the act of reproducing the sound. This imperfect mobility of the reproducer as a whole to the unevenness and irregularities of the record tablet while remaining rigid and entirely unaffected by the minute undulations of the sound-groove which cause the vibrations of the diaphragm, is absolutely essential to any practical talking machine. The floating producer is essential to successful reproduction from a record engraved in the wax or wax-like material, but a record groove engraved in wax or wax-like material is not essential to the successful operation of the floating reproducer. This form of reproducer is also highly advantageous when operating in conjunction with a laterally undulating or zig-zag record, etched in metal or otherwise formed in suitable resisting material, because in such forms of record there are the same irregularities of construction, such as warping, changes due to temperature and variations due to forming a record on one machine and reproducing it in different relations, which are common in records cut or engraved in wax or wax-like material.

The immense value of this floating reproducer in the art of recording and reproducing sounds will be best appreciated by remembering that there is not a practical talking-machine known in the world to-day that does not use it, and prior to its invention by Bell & Tainter, there is not a known example of its use. This beautiful conception, whereby Bell & Tainter allow the reproducer head with its supported diaphragm to smoothly float over irregularities of the tablet surface while still holding the diaphragm in position to respond accurately to the undulations of the sound groove, was embodied in the universally jointed reproducer, and removed at one stroke many of the difficulties theretofore experienced in this art. I would name as some of the important advantages secured thereby --

- (1) That it wholly did away with the necessity for expert and accurate adjustment of the reproducer by the operator. The universally mounted or floating reproducer automatically adjusts itself.
- (2) It maintains the reproducing style and diaphragm in ideal relation with the undulations of the sound-groove notwithstanding and unevenness or irregularities in the tablet surface of other
- (3) ~~It enables the reproducer to be guided and carried~~ parts of the machine.
- (3) It enables the reproducer to be guided and carried along by the sound groove, so that the reproducer is free to follow the same and move across the record in a line parallel with the surface thereof.

Prior to the Bell and Tainter invention described in patent No. 341,214 in suit a sound record had, so far as I am aware, never been made upon one machine and removed therefrom and reproduced upon another and different machine: nor had any invention been devised whereby a record could be removed therefrom and replaced at will thereon for reproduction. For the first time in the history of the art patent No. 341,214 disclosed a removable sound record. This was an advance step of vast importance. It made it possible for one person to make a record, remove it from a machine and send it by mail or otherwise to another person at a distance who could place it on a similar machine and reproduce it. The feature of a removable sound record lies at the foundation of the immense trade in sound records that has sprung up since the date of the Bell and Tainter patent. Without this feature of the removable record, it is manifest that the commercial field open to talking machine would be so limited as to be of little value, whereas with the removable record correspondence can be carried on by mail between two persons having similar machines, and dramatic, musical and other productions can be recorded and the records sold for purposes of instruction and amusement. In this latter branch alone there are hundreds of thousands expended annually. And yet valuable as the removable record is in this art, essential as it is to the commercial practice of the art, such removable record would be practically impossible without the employment of the floating or gravity reproducer. It would not be possible to construct commercial machines with such accuracy as to enable the record to be

accurately and successfully reproduced on any one of them without the employment of this floating reproducer. In short, while the removable record is an absolute necessity in the commercial practice of the art, such record would be utterly valueless in the absence of the floating or gravity reproducer.

There are other details of improvement over the prior art mentioned in the Bell and Tainter patent in suit, but as they do not relate particularly to the reproducing devices to which your question is specifically directed, I have not mentioned them in connection with such devices.

Q.6 Have you read and do you understand the construction and operation of the mechanism described in "Complainant's Exhibit Patent No 341,238 in Suit?"

A. I have read and understand the patent referred to.

Q. 7. Please state what, if any, improvements in the reproducing devices you find described in said patent, with particular reference to claim 44 thereof?

A. The reproducer defined in claim 44 of the patent mentioned is best shown in Figs. 12 and 15 of sheet 5 of the drawing, the latter figure affording a very clear illustration of the construction defined by the claim.

Rigidly secured at one end to the frame or head of the reproducer, is a flat spring 359. This spring has a style 382 of Fig. 15 secured to it on one side, while the other side of the spring is in connection with the diaphragm 362 through the metal button 284. As the point of the style is vibrated by the undulations of the sound groove, the spring 359 by its bending in and out transmits the vibra-

the vibrations through the rigid connections 384 to the diaphragm, the spring serving as a sort of elastic hinge to unite the style to the frame and the button serving as the transmitting medium between the spring and diaphragm.

In the patent the particular form of record shown is one with undulations perpendicular to the plane of the surface, and the particular form of reproducer shown is designed for use with records of this character, the point of the style being located approximately opposite the centre of the diaphragm, but it is manifest that the same principle of mounting the style on the frame with a yielding connection through which the vibrations of the style are transmitted to the diaphragm, may be applied to a reproducer having the style point projecting beyond the edge of the frame after the manner shown in Figures 7 and 9 of the Bell and Tainter patent No. 341,214 in suit, and that a style so projecting may be used in connection with either a vertically undulating sound groove of the kind described in the Bell & Tainter patent No. 341,214 in suit, or with a zig-zag or laterally undulating sound groove such as the etched record groove described in the French patent to Cross to which I have heretofore referred. That the illustration and description contained in patent No. 341,288 in suit were merely intended to illustrate the inventive ideas without defining the limits of the invention is very clear, as the patent states, in line 57 to 67 page 9, that "in the foregoing description of the machine shown in the drawing dimensions, proportions, materials, and other details of construction are mentioned with particularity for the purpose of enabling others more

readily to make and use the new improvement, and not as limitations of the said improvements, since it is obvious that modifications can be made in details without departing from the spirit of the invention, and that parts of the invention can be used separately."

From this it is apparent that more modifications in details which still preserve the spirit of the invention, were clearly contemplated by Prof. Tainter, and claim 44, to which you particularly call attention, is evidently phrased with the same idea, i.e. that the invention is broader in scope than the particular form of reproducer shown and described in the patent. This claim is as follows:

"44. The combination, with the reproducer style and the diaphragm or device upon which the reproduced sonorous vibrations are to be impressed by said style, of a flat metal spring interposed between the style and diaphragm and forming a yielding connection, through which the reproducer vibrations are transmitted, said spring having a practically rigid connection with the diaphragm, substantially as described."

For the reasons given I understand the term of this claim are clearly intended to include any form of reproducer which has a spring upon which the reproducer style is supported and which spring has a rigid connection between it and the diaphragm so that the spring forms a yielding connection or elastic hinge through which the vibrations of the style are transmitted to the diaphragm, and this of course includes not only the form of reproducer with the style projecting beyond the edge of the frame but the form with the style point opposite the face of the diaphragm as well.

Q.7 - Have you read and do you understand the mechanism described in "Complainant's Exhibit Patent No.375,579 in Suit" and if so please state what improvement in the reproducing devices you find therein having reference particularly to claim 20 ?

A - - I have read and understand the patent No.375,579 to Tainter referred to in your question. That portion of the mechanism to which your question particularly relates, viz: the reproducer, is best illustrated in Fig.V of the drawings which show a reproducing diaphragm 90 mounted in a suitable frame and connected to one arm of a lever 93, the other arm of which is in contact with and is vibrated by the undulations a sound groove. The lever is in this instance shown as connected to the diaphragm by a thread 94 and is mounted to turn on its fulcrum 970, so that the vibrations imparted to the style point by undulations in the sound groove will be transmitted through the connecting thread to the diaphragm. One of the great advantages secured by thus forming the style as a two armed lever turning on a fulcrum with one arm connected to the rubbing point which passes over the undulations of the sound groove, is that it is thereby rendered possible to regulate the amplitude of vibration of the diaphragm relatively to the amplitude of the undulations of the sound groove. Thus, if it is desired that the amplitude of vibration of the diaphragm shall be equal to that of the undulations of the sound-groove, the two arms of the lever will be made of equal length.

On the other hand if it be desired that the amplitude of vibration of the diaphragm shall exceed that of the re-

cord undulations, the arm of the lever connected to the diaphragm is made longer than the arm bearing the rubbing point; while if it is wished to have the amplitude of vibration of the diaphragm less than that of the record undulations, then the arm of the lever which is connected to the diaphragm is made shorter than the arm bearing the rubbing point. Thus the patent says, lines 98 to 105, page 5:-

"One advantage of using a lever as the reproducing style is that by making the inner arm shorter than the outer, as shown in the drawings, the motion of the diaphragm can be reduced, which, though it involves a slight loss in loudness, is found to produce a more than compensating gain in distinctness of enunciation."

The converse of this statement is equally true. That is by making the inner arm of the lever longer than the outer the amplitude of vibration of the diaphragm can be increased, which would involve a gain in loudness of the reproduced sounds, but doubtless with a loss in distinctness.

Claim 20 does not state specifically any one of the three constructions which I have just described; it does not state what the relative length of the arms of the lever are, but is phrased in terms broad enough to include all of them.

It reads:

"20 The combination with the diaphragm of the reproducer of the rubbing style consisting of a lever having the rubbing point formed on one arm and the other connected with said diaphragm, substantially as described."

In view of the wording of this claim and of the statement in the specification that "it is obvious that modifications may be made without departing from the spirit of the invention, "I do not regard the particular kind of lever,

or character of connection between such lever and the diaphragm, as at all material. Thus, a bell crank lever is shown in the ~~f~~ drawing of the patent, and a thread connection is shown between the lever and the diaphragm, but I should regard a straight lever, one arm of which was connected to the diaphragm either by a thread or directly connected thereto by cement or otherwise, as being generally included in the terms of this claim.

Q. 8. Do you understand the construction and mode of operation of "Complainant's Exhibit Defendants Machine" and "Complainant's Exhibit Defendants Sound Record". If so, please explain the same ?

A. I have carefully and repeatedly examined the machine and record to which your question refers and am thoroughly familiar with the construction and mode of operation of the same. The record is of the disk form having upon one of its sides a spiral groove of even depth whose undulations are parallel with the surface of the tablet, that is, it is the zig-zag type of record which Cross described in his French patent of 1878 as being the type which he preferred. I observe that it is marked "E.Berliner's Gramophone, Patented Nov.8, 1887, May 16, 1888, May 6, 1890, Feb.19, 1895, Oct.29, 1895, other patents applied for", and I find these dates to be those upon which the following United States patents were granted to E.Berliner, viz:

No.372,786, dated November 8th, 1887.

382,790, " May 15th., 1888.

427,279, " May 6th., 1890.

(E.Berliner, assignee of Sues)

534,543, dated Feb.12th.1895.

543,623, dated October 29th,1895.

I have carefully read these patents and also a pamphlet entitled "Paper read before the Franklin Institute, May 16, 1888, on the Gramophone, by its inventor, Emile Berliner", and "Published by the United States Gramophone Company, Washington, D.C." Mr. Berliner's patent No. 372,786, sets out a process of forming a sound record which consists in forming by means of a phonautographic apparatus a record upon a travelling layer of lamp-black, then transferring this phonautographic record by photoengraving upon metal, which metallic record was to be used for reproducing.

This is exactly the method described by Cross in his French patent and Mr. Berliner, after filing the application upon which his patent of November 8th. 1887, No. 372,786, was granted, discovered that Cross had anticipated him by about ten years and he, Berliner, thereupon discarded that method for another, described in his patent of May 15th., 1888 No. 382,790, which method consists in producing a phonautographic record through a film of beeswax or paraffine (instead of lampblack) on a metallic surface, and then subjecting the metal where it was exposed along the lined of the record the action of an etching acid. This precise method was also disclosed in the French patent to Cross wherein it is said.

"the lamp-black can be replaced by a body insulating an underlying metallic plate from the engraving action of an acid."

Cross mentioned paraffine as an example of the insulating material with which to cover the metallic plate, to form the etching ground, and Berliner in his said patent No.

332,790 simply followed the directions given ten years before by Cross in his French patent No.124,213, that is, he covered a plate with a thin coating of film of some substance such as paraffine and then traced a phonautographic or transversely undulating zig-zag record through this film, thus exposing the plate along the zig-zag line and then applied a suitable acid which would not attack the paraffine film, but did etch or eat out the plate where it was exposed along the zig-zag line; in other words he followed the ordinary and at that time well known process of etching. This gave him a record etched in the metal plate, the same being precisely the record which was secured under the French patent to Cross above referred to. Claim 1 of Berliner's patent No.332,711 is as follows:

- "1. The method of process of producing a record of sound-waves in solid resisting material for reproduction of the recorded sounds, which consists in covering the surface of such material with a film of etching ground that offers no perceptible mechanical resistance, then making a phonautographic record upon and through the etching ground, and then exposing the record to the action of a suitable etching agent, substantially as described."

This is a precise statement of the method described by Cross in his French Patent with the single exception that the material for the etching ground is described as offering no perceptible mechanical resistance, but inasmuch as the Cross Patent mentions paraffine as an example of the insulating material, and Berliner also mentions paraffine as an example of the material forming his etching ground, the particular expression used to define that material in the claim is unimportant. It is only conceivable that this claim as well as some of the other claims of this patent

could have passed the scrutiny of the Examiners in the Patent Office, because as Mr. Berliner says in his Franklin Institute paper mentioned above, "not even the Examiners at the Patent Office knew anything of Mr. Cross." In this connection I note in the Franklin Institute paper Mr. Berliner acknowledged Cross as the originator of the lamp-black photoengraving method which he, Berliner, knew to be impracticable, but he says nothing about Mr. Cross in connection with the etching method.

In his patent No. 548,623 of October 29th., 1895, Mr. Berliner describes a method of duplicating in hard rubber the records etched in metal by the process set forth in the patent No. 382,790, that is the Cross process as set out in French patent No. 124,213. This method of duplication consists in forming a copy of the etched record in relief or reverse, and then using this copy as a stamp or die to secure an impression in hard rubber, the latter being softened by heat for the purpose.

As the record "Complainant's Exhibit Defendant's Record" is made on a disk of what appears to be hard rubber, and as it is made under the patents of May 15th., 1888, May 6, 1890 and October 29th., 1895; and as I have examined the same under a microscope and find it to have upon ~~the~~ its face a transversely undulating or zig-zag spiral line, which when acting in conjunction with a reproducer produces sound; I have no hesitation in saying that the same is a sound-record stamped in a hard rubber tablet by a reverse or relief copy of a zig-zag record, etched in metal by substantially the method described by Cross in his French patent No. 124,213 of 1878. In other words it does not dif-

fer from the record of the Cross patent in any particular other than that it is formed in a rubber instead of a metal disk, and this is merely for the purpose of affording a cheap means of duplication and does not produce any change either in character or function. From this it will be clear that more than ten years prior to Berliner Cross had told the world how to etch exactly this record in metal. It does not appear that Cross ever actually constructed any means whereby he could reproduce sound from his record. In fact, it was not until Bell and Tainter invented their loosely mounted or floating reproducer some years later that a commercially practical reproducer was known. Upon carefully examining Complainant's Exhibit Defendants Sound Record under a microscope, I find that the spiral sound groove thereon has sloping walls, that is the groove in cross section is V shaped with the point of the V slightly rounded. It is therefore the kind of a sound groove for which Bell and Tainter described their loosely mounted or floating reproducer as being specially adapted. In lines 101 22, page 1, to line 3, page 2, of the patent No. 341,214, in suit, it is stated:

"The reproducing style mounted as just explained is specially adapted for use in connection with a record in the form of a groove with sloping walls, and this combination is specially claimed; but it may also be usefully employed in connection with other forms of record."

at the time of filing their application for patent No. 341,214 in suit, Bell and Tainter were undoubtedly acquainted with the various forms of record, the Edison indented, the Cross etched, and their own engraved record, and the

sentence which I have just quoted very clearly shows that they fully appreciated the value of the floating reproducer when used with "other forms of record" than their engraved form. I have carefully observed the action of the reproducing styl e on Complainant's machine in conjunction with sound groove of Complainant's sound record and have studied the action of the same under the microscope. I find that the grooves are exceedingly fine and thread-like and quite shallow, and that notwithstanding the fact that the reproducer point seems sharp to the touch, that it is, when compared with the thread-like groove of the record, quite blunt. When the point of the style rests in the groove it travels along the bottom thereof fully filling the groove and contacts at all times with the walls of the groove on both sides; that is, the style does not move back and forth across the groove, but fits snugly therein so that the sloping walls of the groove act simultaneously on the opposite sides of the style point and guide the same. I have also observed that notwithstanding the fact that the sound groove themselves are considerably narrower than the lands or spaces between the grooves, that it is unnecessary when starting the machine to use any care when placing the style upon the record to adjust the style point within the sound groove, as the same will speedily approach the edge of such groove and at once gravitate down the sloping side thereof until it assumes the proper adjustment in the groove, after which the ^{groove} guides the reproducing point, and by reason of the universal mounting of the reproducer the grooves with its

sloping walls compels this reproducer to follow the groove.

"Complainant's Exhibit Defendants Machine" consists of a revolving table supporting the record, (the table being driven by a clock-work motor,) the machine being provided with a loosely mounted reproducer resting by gravity upon the record. The reproducer proper (that is the frame or head with its supported style and diaphragm) is carried at one end of a wooden arm which is connected to the frame of the machine by a universal joint. This construction is shown in Fig.1 of U.S.patent No.427, 279, May 6th.,1890, issued to Emile Berliner as the assignee of Warner Suess, in which patent it is stated that this mounting constitutes a universal joint and is so arranged that the stylus rests lightly but with sufficient pressure on the tablet with its point in the record groove, and that reliance is placed upon this control of the stylus by the walls of the record groove for the movement of the stylus across the face of the disk; or as it is stated in Berliner's patent No.534,543 (where this ~~connection~~ construction is shown in Fig.3) -

"The rotating record groove will guide the stylus across the face of the tablet".

(The italics are mine)

When "Complainants Exhibit Defendants Record" operates in combination with "Complainant's Exhibit Defendants Machine" there is a record groove with sloping walls which forms an efficient guide to the reproducing style combined with a reproducer loosely mounted so that it can readily be

guided by the record, that is, it constitutes precisely the invention set forth in the third and fourth paragraphs of the statement of invention in the Bell and Tainter patent No. 341,214 in suit.

Referring more particularly to the specific construction of the reproducer, I find that it consists of a metallic frame or head having a diaphragm, apparently of isinglass, secured therein, and a flat metal spring secured at one end to the frame of the reproducer and having a rigid connection with the diaphragm, the spring also having the style connected to it by a set screw, which style projects outside of or beyond the edge of the instrument. Furthermore, the style point, (when retained in place by the set screw with the arm rigidly connecting the flat spring to the diaphragm) constitutes a lever having a rubbing point formed on one arm and the other arm connected with the diaphragm, the arm which is connected to the diaphragm, is longer than the arm having the stylus point.

The result of this will be that any vibration of the stylus point will cause a vibration of greater amplitude in the diaphragm. As I have before explained, such a construction would have a tendency to increase the loudness of the reproduced sounds, but at the expense of the purity of quality, and by placing this reproducer on Defendant's machine with Defendants' record, I find the resulting reproduced sounds to be quite loud but exceedingly harsh and disagreeable to the ear.

Adjourned by consent to Wednesday March 29th, 1899 at 10.A.M.

Washington, D.C.,

March 29, 1899.

Met pursuant to adjournment.

Present:

Parties as before.

Q. 10 - Please state whether or not you find the constructions defined in any of the claims of the patent No. 341,214 in suit embodied in "Complainant's Exhibit Defendants' Machine" or "Complainant's Exhibit Defendants' Record", and if so, please indicate the particular claims, giving your reasons for any conclusions you may reach?

A. I find in the machine referred to the construction defined in Claims 19, 20, 21 and 25 of Patent No. 341,214 in suit, and when said machine is combined with defendants' record I also find the construction defined in claims 22 and 23 of each patent.

For the sake of clearness I will consider these claims one at a time and point out the features in defendants' machine and record which respond to the demands of each claim.

Claim 19 reads as follows:

"19. The combination, with a reproducing style, of a mounting therefor, which leaves said style face to move laterally and thereby adjust itself automatically to a sound record, substantially as described."

I note that this claim uses the expression "style face to move laterally" but I find upon inspection of the original specification in the files of the Patent Office that this should be "styled free to move laterally."

Turning now to Defendants' machine, I find that it has a reproducing style, which is the metal point resting upon the record; I find this style combined with a mounting,

which is the reproducer head and the long wooden arm supporting it; and upon operating the machine with defendants' record thereon I find that this mounting is such that it leaves the style free to move laterally by reason of the turning the wooden arm upon its vertical pivot pin, and that as a consequence the style automatically adjusts itself to the record. I have repeatedly demonstrated that the mounting of the reproducing style in defendants' machine is such as to leave the style free to move laterally and that by such movement it adjusts itself automatically to the record. I have many times placed the style carelessly upon the record, using no effort whatever to adjust it thereon, and that upon starting the machine the style invariably adjusted itself automatically to the record as perfectly as if the utmost care had been exercised. I have removed one record and placed another upon the machine without any effort at adjustment, and always with the same result, the style shifts laterally and automatically adjusts itself to the record.

There are but two elements mentioned in the claim, viz. the reproducing style and the mounting therefor. Both of these elements are found in Defendants' machine, and when combined they operate precisely in accordance with the terms of the claim. I am not unmindful of the fact that the wooden arm constituting the mounting for the reproducing style in Defendants' Machine is longer than that shown in the Bell and Tainter patent, but I fail to find in the description of the patent, or in the terms of the claim, anything whatever limiting the invention to any particular length of arm, and in as much as the ~~function~~ function of the

style thus mounted is precisely the same in Defendants' Machine as in the construction shown in the patent, I do not regard the matter of the length of the wooden arm in defendants' machine as of any importance whatever.

I have no hesitation, therefore, in stating that I find in Complainant's Exhibit Defendants' Machine the precise combination, operating in the identical manner defined in said claim 19 of the Patent No. 341,214 in suit.

Claim 20 reads:

"20. The reproducer loosely mounted on a suitable support, so that the reproducing style is capable of a lateral movement and may in consequence thereof adjust itself automatically on the record, substantially as described."

I find in Defendants' Machine a reproducer, which is the metallic frame or head together with its supported diaphragm and style; I find this reproducer mounted on a suitable support which support is the metallic arm extending out from the side of the box enclosing the motor; furthermore I find that the reproducer is loosely mounted through the mediums of the wooden arm pivoted upon said support so that the reproducer is capable of a lateral movement, and that as a consequence of such capacity for lateral movement the reproducing style is free to and does automatically adjust itself on the record.

The loose mounting whereby the reproducing style is enabled to move laterally consists, as I have stated above, in the long wooden arm carrying the reproducer and swinging in a horizontal plane around its pivot pin bearing in a socket on the outwardly extending metallic arm or support.

When Defendants' record is placed on the machine and

the reproducing style allowed to rest on the record, if the style point falls on one of the lands or ridges between the sound grooves, rather than within one of the grooves, on revolving the record the style immediately shifts laterally, thus adjusting itself on the record. Moreover, I notice that this capacity for lateral movement not only enables the style to adjust itself to the record groove, but that the style "follows" the record groove from the outermost to the innermost spiral thereof, thus doing precisely the two things which Bell and Tainter say in their description this freedom of lateral movement for the style is designed to do, that is, permits the style to "adjust itself to the record" and then follow the record. The specification says "the reproducer x x in consequence of the flexibility of the rubber tubing 32 is free to follow the record," page 4, lines 57 to 63.

I do not overlook the fact that in the construction shown in the Bell and Tainter patent means are provided whereby the record is not only revolved but is also intended to be given a movement in a straight line past the reproducing style, while in Defendants' Machine the record is only revolved and the style point is moved across the record in an arc which approximates a straight line. I do not, however, regard the patent as limited to a construction wherein the record has this rectilinear movement. The specification expressly states that "it is evident that various modifications other than those indicated can be made and the invention

still be employed in whole or in part, and also that parts of the invention can be used separately". (Page 6, lines 42 - 47)

And the specification further points out that there is a liability to disarrangement whereby the record will not have this movement and explains that in such or similar cases the capability of free lateral movement which the style has be reason of its loose mounting will enable it to follow the record as well as adjust itself thereto.

The patent says, page 4, lines 68 - 84:

"There exists always a liability to disarrangement in some part of the machine either in the recorder or the support therefor or the recording tablet or its support, or if there is no disarrangement it will be difficult to insure that the reproducing style should touch the record precisely at the proper point if the reproducer be held rigidly. Difficulties on these accounts are avoided by the loose or flexible mounting of the reproducer, the style automatically adjusting itself to the proper place on the record. It will be seen that the reproducer is mounted on a universal joint so that it can move in any direction. The movement parallel with the face of the tablet would, however, by itself allow the style to follow and adjust itself to the record to a useful extent."

(Italics mine)

It is apparent therefore that the freedom of lateral movement possessed by the reproducer with its supported style in defendants' machine, confers upon such reproducer and style precisely the functions which the patent pointed out as resulting from the loose mounting and free lateral movement defined in claim 20.

For the reasons given I am of the opinion that the exact construction defined in claim 2 30 is found in Complainant's Exhibit Defendants' Machine.

The 21st. claim reads:

"21. The reproducer mounted on a universal joint and held against the record by yielding pressure, substantially as described."

As I have before pointed out, I find in Defendants' Machine a reproducer, which is a metallic frame or head with its supported diaphragm and style point, such reproducer being carried by the long wooden arm, which arm is mounted at its outer end on the outwardly extending metallic arm by means of the vertical and horizontal pivots constituting a universal joint therefor. When defendants' record is placed upon the machine and the reproducer put in position to cooperate therewith, the reproducer is held against the record by the yielding pressure due to its own weight, or as the patent No. 427,279, granted to Berliner as the Assignee of Sness, defines the action of this construction "the stylus rests lightly, but with sufficient pressure, on the tablet with its point in the record groove." The reproducer is free to rise and fall in response to any irregularities, (such as warping of the record) without in any way interfering with the contact between the style point and the undulations of the sound groove. In short it is a gravity or floating reproducer. I have demonstrated this repeatedly by placing a badly warped record on the machine in conjunction with the reproducer and have found that the latter rises and falls with the warped surface of the record, yielding to the inequalities or irregularities due to the warping, without once withdrawing the style from the groove, exactly as a cork would rise and fall with the waves of the sea. Very clearly then the construction defined by Claim 21 is embodied in Defendants' Machine.

I quote Claim 22 :

"22. The combination, with a grooved tablet or other body having a sound record formed therein, of a reproducer having a rubbing style loosely mounted, so that it is free to move laterally and thus adjust itself to the groove, substantially as described."

When defendants' Record is employed, as it is intended to be, upon Defendants' Machine, I find a grooved tablet having a sound record formed therein; I find a reproducer having a style rubbing in said groove, and, as I have explained in connection with Claim 20 this style is loosely mounted so that it is free to move laterally and thus adjust itself to the groove. Each element of claim 22 having the identical construction defined by the claim, is found in defendants' combined machine and record, and the element co-act in exact accord with the terms of the claim. Clearly therefore, the construction defined by claim 22 is found in defendants' combined machine and record.

Claim 23 is as follows:

"23. The combination, with the tablet or other body having the sound record formed therein as an irregular groove with sloping walls, of a reproducer having a style for rubbing over said record, and mounted on a universal joint, substantially as described."

In Complainants' Exhibit Defendants' Record mounted upon and operating with Complainant's Exhibit Defendants' Machine I find the combination of a tablet, which tablet has a sound record formed therein, as I have demonstrated by operating the machine and obtaining reproductions of sound therefrom. Such is in the form of a groove, which groove upon inspection I find to be irregular in character, that is, it is a spiral groove with irregularities or zig-zag sinuosities correspond-

ing to sound waves, and upon carefully inspecting such groove under a microscope I find, as I have heretofore stated, that the walls of the groove slope towards each other so that in cross section it is of V-shape with the bottom or point of the V-slightly rounded. I find therefore a tablet having a sound-record formed therein as an irregular groove with sloping walls as demanded by claim 23. As I have pointed out in connection with claims 19, 20 and 21, the reproducer of Defendants' Machine is mounted on a universal joint and I find that upon operating the machine in conjunction with the sound-record constructed as I have just described, the style of such reproducer rubs over the record as demanded by said claim 25.

I have heretofore pointed out that this sound groove with sloping walls, as found in Defendants' Record, does exactly what the ~~xxxxxx~~ inventors Bell and Tainter point out in their patent in suit that it is intended to do, that is it "forms an efficient guide to the reproducing style." Not only do my own experience and observation with the defendants' record prove that its groove with sloping walls forms an efficient guide for the reproducing style, but I find that Mr. Berliner himself states in his U.S. Patent No. 534,543 (page 25, 26) that "the rotating record groove will guide the stylus."

I find therefore that when Defendants' Machine is operating in combination with defendants record it embodies a tablet having a sound record formed therein as an irregular groove with sloping walls with ~~xxxxxxxxxxxx~~ a reproducer having a style for rubbing over said record and mounted on a

universal joint as demanded by claim 23.

Claim 25 reads:

"25. A reproducer having a style projecting beyond the edge or end of the instrument so that the position of the point of the style on the record may be readily seen, substantially as described."

The style in the reproducer of Defendants' Machine is attached to the frame or head of the instrument so as to project beyond the edge thereof to the extent of about half an inch, being secured to the frame by means of a small set screw. By reason of this projection beyond the edge of the instrument the position of the style on the record may be readily observed. Clearly then the construction defined in Claim 25, viz: a reproducer having a style projecting beyond the edge of the instrument, is found in Defendants' Machine.

Q. 11 Please state whether or not you find the construction defined in claim 44 of the Tainter patent No. 341,288 in suit embodied in Defendants' Machine, giving your reasons for your conclusions ?

A. Claim 44 of the patent referred to reads as follows:

"44. The combination, with the reproducer style and a diaphragm or device upon which the reproduced sonorous vibrations are to be impressed by said style, of a flat metal spring interposed between the style and diaphragm and forming a yielding connection, through which the reproduced vibrations are transmitted, said spring having a practically rigid connection with the diaphragm, substantially as described."

I have heretofore explained that Defendants' Machine has a flat spring attached to the side of the reproducer frame and that the style is secured on one side of said spring, the other side of which spring has a rigid connection with the diaphragm through an arm which is united to the spring and

cemented to the diaphragm. 45. By means of this construction the spring forms a yielding connection through which the vibrations of the style are transmitted to the diaphragm.

Claim 44 has four elements, the reproducer, style, the diaphragm, the flat metal spring interposed between the style and diaphragm, and the rigid connection between the spring and diaphragm. I find these four elements in the reproducer of Defendants' Machine arranged and co-acting in precisely the manner defined by Claim 24, and I therefore find in defendants' machine the construction defined by said claim.

Q. 12 - Please state whether or not you find the construction defined in Claim 20 of the patent to Tainter No. 375,579 in suit embodied in Defendants' machine, and if so, please give your reasons for your opinion?

A. Claim 20 of patent No. 375,579 in suit is as follows:

"20. The combination, with the diaphragm of the reproducer, of the rubbing style consisting of a lever having the rubbing point formed on one arm and the other connected with said diaphragm, substantially as described."

The reproducer of defendants' machine has a diaphragm which is combined with a lever fulcrumed on the flat spring attached to the side of the reproducer, the longer arm of the lever having its end connected to the diaphragm, and the shorter arm having a rubbing style point projecting beyond the edge of the frame of the reproducer. As this is the identical construction defined in Claim 20 above quoted, I find in defendants' Machine the construction defined in said claim.

IN THE CIRCUIT COURT OF THE UNITED STATES, 43

FOR THE SOUTHERN DISTRICT OF NEW YORK.

AMERICAN GRAPHOPHONE COMPANY

vs.

NATIONAL GRAMOPHONE COMPANY and Frank Seaman.

In Equity.

Proofs for final hearing taken on behalf of complainant under the provisions of the 67th Rule in Equity, pursuant to agreement before Reeve Lewis, a notary public in and for the District of Columbia, acting herein as Special Examiner by consent, at the offices of Philip Mauro, Esq., No. 620 F street, N. W., Washington, D. C., beginning March 27th, 1899, at 11 A. M. 44

Present—PHILIP MAURO, Esq., for Complainant.
GUSTAVE BISSING, Esq., and HORACE PETTIT, Esq., for Defendants.

Complainant's counsel offers in evidence Patent Office copies of the following Letters Patent, to wit: 45

(1) No. 341,214, to C. A. Bell and S. Tainter, dated May 4th, 1886, to be marked "Complainant's Exhibit Patent No. 341,214, in suit."

(2) No. 341,288, to S. Tainter, dated May 4th, 1886, to be marked "Complainant's Exhibit Patent No. 341,288, in suit"

(3) Patent No. 375,579, to S. Tainter, dated December 27, 1887, to be marked "Complainant's Exhibit Patent No. 375,579, in suit."

46

And also offers for identification a machine to be marked "Complainant's Exhibit, Defendants' Machine for Identification," and

A sound record to be marked "Complainant's Exhibit, Defendants' Sound Record for Identification."

And thereupon, SHELTON T. CAMERON, a witness produced on behalf of complainant, being first duly sworn and cautioned to tell the truth, the whole truth and nothing but the truth, deposes and says:

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Q1. Please state your name, age, residence and occupation.

A. Shelton T. Cameron; 41 years of age; residence, Washington, D. C.; occupation, solicitor of patents and expert in patent causes.

Q2. State briefly what experience you have had in examining patented and other structures, and comparing the same for the purpose of determining questions of identity and dissimilarity, and generally your experience as an expert in patent causes?

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A. As a youth I was greatly interested in mathematics and mechanics and spent much time in workshops and manufactories studying the construction and operation of mechanical structures, and in my mature years I have continued such studies visiting in the line of my profession numerous establishments where different mechanical devices were in active operation. For more than eight years I was an assistant examiner in the United States Patent Office where it was a part of my daily duty to study devices for which patents were sought, to compare the same with the State of the art as disclosed in domestic and foreign patents, as well as in printed publications, and to report upon the same. In the practice of my profession I have prepared and prosecuted numerous

applications for patents and have been repeatedly 49
called upon to testify as an expert before the U.
S. Courts in patent causes.

Q3. Are you familiar with the art of recording
and reproducing sounds, as practically carried on,
and with the literature of that art, and if so,
please state how such familiarity was acquired?

A. I am quite familiar with the art referred to,
not only as the same is practically carried on, but
as such art is disclosed in patented and unpat-
ented structures and in the literature relating
thereto. Since entering upon the practice of my
profession I have prepared and prosecuted numer-
ous applications relating directly or indirectly to 50
this art, and have repeatedly given expert affida-
vits and testified as a mechanical expert in causes
before the U. S. Courts for alleged infringements
of talking machine patents. I have repeatedly
testified as expert witness in causes in which the
Bell and Tainter patent No. 341,214 and the Tain-
ter patent No. 341,288 here in suit have been in-
volved. I have already given an expert affidavit
in this cause in connection with the motion by
complainant for a preliminary injunction.

Q4. Have you read and do you understand the
invention set forth in Complainant's Exhibit Pat-
ent No. 341,214 in suit?

A. I have read and understand the patent re- 51
ferred to.

Q5. What improvements and invention, in view
of the prior art, do you find described and claimed
in said patent, having reference particularly to
the reproducing devices?

A. The invention set forth in patent No. 341,214
consists of a method of and apparatus for record-
ing and reproducing speech and other sounds.
The art of recording and reproducing acoustical
vibrations necessarily consists of two distinct oper-
ations, viz.: First, the recording of the acoustical
vibrations; second, the reproduction from the rec-

52 ord obtained by the first operation of vibrations similar to the original or recorded ones. The first of these operations, *i. e.*, the recording of sound waves, was a familiar one to scientists for many years before it was discovered how to perform the second, or reproducing operation. As early as 1857 one Leon Scott devised an instrument subsequently known as the "Scott Phonautograph," which produced a *visual* record of sound-waves. Scott's phonautographic record was obtained by coating a tablet with lamp-black and allowing a style carried by a suitable diaphragm to rest against the tablet while the latter was revolved and at the same time given a rectilinear motion
53 past the style. In the absence of sound the style traced a regular spiral line of even depth in the lamp-black on the surface of the tablet, but when sound-waves were caused to impinge upon the diaphragm the spiral line traced by the style in the lamp-black became an irregular, zig-zag or sinuous line of even depth, the sinuosities of which were in a plane parallel with the surface of the tablet and corresponded in form to the sound-waves impinging upon the diaphragm. This gave a visual record of the acoustical vibrations, but there was no known way to reproduce sounds therefrom.

54 By Alexander Graham Bell's invention of the speaking telephone it was clearly demonstrated that if a diaphragm was caused to vibrate by or in accordance with sound-waves and a second diaphragm were mechanically caused to copy or vibrate in imitation of the vibrations of the first diaphragm, the sound which set the first diaphragm vibrating would be reproduced by the second. This suggested the possibility of securing a record of the vibrations of the first diaphragm in material of sufficient solidity to be utilized in imparting vibrations to the second diaphragm, and in this suggestion the art of recording *and* reproducing sounds had its birth.

Two inventors, one a Frenchman named Charles Cros, and another an American, Thomas A. Edison, nearly simultaneously invented means by which this suggestion could be carried into effect. As the invention of Cros was a carrying forward or elaboration of the Scott Phonautograph I will describe it first. 55

On April 30th, 1877, Mr. Cros deposited with the French Academy of Sciences a description of his method in which he said:

"Process of Recording and Reproducing Audible Phenomena. In general my process consists in obtaining the tracing of the to-and-fro movements of a vibrating membrane, and the utilization of this tracing for reproducing the same to-and-fro movements, with their relative inherent durations and intensities in the same membrane, or in another adapted for furnishing the sounds and noises which result from this series of movements. 56

We are, therefore, concerned with the transformation of an extremely delicate tracing such as that obtained with a delicate stylus rubbing upon a surface blackened by a flame, to transform, I say, these tracings in relief or in intaglio in resisting material, capable of guiding a moving body which transmits these movements to the sonorous membrane.

A light stylus is connected with the center of a vibrating membrane; it terminates in a point (metallic wire, the barb of a feather, etc.), which bears upon a surface blackened by a flame. This surface is a part of a disk to which is given a double movement of rotation and rectilinear progression. 57

If the membrane is at rest, the point will trace a simple spiral; if the membrane vibrates, the traced spiral will be undulating and these undulations represent exactly all the to-and-fro movements of the membrane with their times and intensities "

It will be seen that this is in effect a Scott phonautograph and Mr. Cros then proceeds to describe how he secures from this tracing in lamp black his record in *resisting* material. He says:

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"By means of the photographic process, which, in fact, is well known, this traced, transparent, undulatory spiral is converted into a line of similar dimensions, in intaglio or in relief, in resisting material like tempered steel, for instance.

This done, this resisting surface is, by means of a motor apparatus, made to turn and to progress rectilinearly with a velocity like that which was used in the registration.

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If the reproduced tracing is in intaglio, a metallic point (and if it is in relief a notched finger), held by a spring, bears upon the tracing at one end and is connected at the other end with the center of the membrane adapted for sound reproduction. Under these conditions, this membrane is not any more acted upon by the vibrating air, but by the tracing controlling the pointed stylus by pulsations exactly like those to which the membrane was subjected in recording, both as to duration and intensity. The spiral tracing represents the successive equal periods by its increasing and decreasing length. There is nothing inconvenient in this if only the outer portion of the rotating circle is used, and if the spirals are close together except that the central part of the disk is lost.

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In all cases, however, a helical tracing upon a cylinder is much to be preferred, and I am actually engaged in finding a practical embodiment of this."

May 1st, 1878, Cros took out a French patent No. 124,213, in which he said, speaking of different kinds or forms of sound records which might be made:

"The question is of registering by a continuous tracing the vibrations of a diaphragm.

I see three kinds of tracings; a transversely undulating tracing; a tracing undulated in depth; a simple lineal tracing, straight or rectilinear which I will call the straight tracing. * * *

The tracing undulating in depth is that which Mr. Edison adopted, after having abandoned diverse projects based on the straight tracing. This tracing requires a notable force of the stylus on a yielding substance. 61

Tin foil gave the first results. Despite the reducing advantage of the immediate repetition, despite the facility and simplicity of its use, I do not believe in the future of tin foil in phonography. However, tin foil has been proposed and used with success for the first time by Mr. Edison.

It will be seen further on that I obtain the immediate repetition by another process which gives moreover the facility of indefinite repetition.

The transversely undulating tracing is that which I propose first. Obtained by lamp-black deposited upon the surface of glass or smooth paper, it is that which requires the least force of the tracing stylus. 62

Consequently it will give more details, more fineness in the results, since it opposes the slightest resistance to the small vibrations, which are also the weakest ones.

It is this process which will give, in my opinion, serious and complete results."

After explaining one method which he follows for obtaining a record in solid material from this transversely undulating or zig-zag tracing in lamp-black, Cros proceeds to indicate a method of etching a zig-zag record in metal by the use of acids. He says: 63

"The lamp-black may be replaced by a body insulating an underlying metallic plate from the engraving action of an acid. In this case the work of the stylus is increased by the cohesion of the insulating substance. Tallow, paraffine, the varnish of *aquae fortis* can serve."

That is, he can take a tablet of metal and instead of lamp-black, coat it with tallow or paraffine or other substance resisting the action of

- 64 acids, and then got his zig-zag tracing in this coating just as the Scott phonautograph did in the lamp-black, after which acid is applied to eat out the metal along the line of the tracing. Briefly stated then Cros disclosed in 1877 and 1878 a method of producing a record of sound-waves in solid resisting material by *photoengraving*, the phonautographic record of such sound-waves having first been produced as an undulatory line of even depth in a traveling layer of non-resisting material, such as lamp-black; and he also disclosed a method of producing a phonautographic record through a film of suitable etching ground deposited upon a traveling surface of resisting material, such as metal, and then subjecting such surface to the *action of an etching agent*, such as an acid which attacked said surface only at the places where the etching ground had been removed by the recording stylus. This record described by the Cros patent of 1878 was a transversely undulating zig-zag or sinuous groove of even depth, though it is evident from the quotations which I have made that Cros understood that there was a record groove with vertical undulations, for he says: "I see * * * the tracing undulated in depth." This record with vertical undulations was the form adopted by Mr. Edison in his tin-foil phonograph of 1878. Edison took a tablet having a spiral groove cut thereon and covered it with tin-foil. A style attached to a diaphragm was supported with its point resting on the tin-foil immediately over the spiral groove. In this case the vibrations of the style were not parallel to the surface of the tablet, as in Scott's phonautograph and Cros' etched zig-zag record, but were perpendicular thereto, and when the tablet was revolved and given rectilinear motion past the diaphragm and style, sound waves impinging upon the diaphragm vibrated towards and from the tablet surface, and caused the style to indent the tin-foil

over the spiral groove formed in the tablet and thereby trace an undulatory spiral line in the tin-foil, the undulations being perpendicular to the surface of the cylinder and corresponding to the sound waves impinging upon the diaphragm. 67

It thus appears that as early as 1878 there were two well known forms of sound records, viz., the zig-zag record of even depth, as in the Cros etched or photoengraved record; and the one of uneven depth with verticle undulations, as in the Edison tin foil record. To reproduce sound from Cros's zig-zag record, whether the same were etched or produced by the photoengraving process, it would be necessary to adjust a style attached to a diaphragm in the record groove and give the tablet the rotation and the rectilinear movement it had when forming the record. The style would rest in the groove whose undulatory or zig-zag side walls would cause the style to vibrate from side to side thus causing the diaphragm to copy the vibrations of the recording diaphragm and thereby reproduce the recorded sounds. 68

To reproduce sound from the Edison indented tin-foil record having vertical undulations, it was necessary to carefully adjust the style of the reproducing diaphragm in the indented groove, and upon rotating the record tablet and giving it rectilinear movement, as was done in forming the record, the indentations in the tin foil would cause the style and its attached diaphragm to vibrate towards and from the tablet and copy in an imperfect way the vibrations of the recording diaphragm. 69

In forming a sound record by either of the above methods it was immaterial whether the tablet was a disk or a cylinder, as in either case the record would be produced in the form of a spiral groove on the surface of the tablet.

While both Cros and Edison describe a means by the use of which it was possible to record and re-

- 70 produce sound, the Edison phonograph amounted to nothing more than a scientific toy, by which the theory of sound reproduction might be demonstrated, and so far as I am aware, Cros never actually constructed the devices described in his French patent. It appears that Edison succeeded in actually obtaining reproductions of sound from his phonograph, but it was found impossible to use this tin-foil phonograph in practical affairs for the intelligible reproduction of speech. Edison's reproducer was adjusted by the exercise of great care and skill into proper relation with the indented record, and then clamped rigidly in position. As the groove of the record is an exceedingly fine, thread like line, this adjustment was very difficult to secure, and even when such adjustment was successfully accomplished it was by no means certain that the proper relation between the style and record would be maintained. Inaccuracies in the construction of the machine, so minute in character that it is mechanically impossible to avoid them, would throw the record groove out of alignment with the style, or would cause the groove to approach too close to, or recede too far from, the point of the style. For example, if the record tablet was a flat disk, any departure of the surface from a true plane, as by warping, even to the extent of a thousandth part of an inch, would cause the record to fail entirely to contact with the style, or else to bear upon it with such force as to iron out or deform the undulations. In fact, the finer and more delicate undulations were ironed out, even with the most accurate adjustments obtainable, while the larger undulations were so distorted that they no longer constituted even an approximate record of the original sounds. Of course, when the style was thus in the act of ironing out an undulation, the latter was not causing the reproducing diaphragm to correctly copy the vibrations of
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the original or recording diaphragm, and consequently the original sounds were not reproduced even the first time the record was used. I might add that the adjustment necessary to secure the proper contact between the style and the undulations or indentations was necessarily so accurate that variations of temperature alone were sufficient to throw Edison's rigidly clamped reproducer out of adjustment so that records made at one temperature could not be reproduced at another temperature.

By the method described in their patent No. 341,214 in suit, Bell and Tainter *cut or engraved* an undulating record groove in a tablet of wax or wax-like material, by means of a cutting style having its point imbedded in the tablet surface, and attached to a vibratory diaphragm upon which sounds to be recorded were allowed to impinge. The tablet of wax or wax-like material is soft enough to enable the cutting or engraving style, when actuated by a force so weak as that of a sound wave to readily cut the undulatory groove therein, and is at the same time sufficiently solid to enable the undulations of the sound groove to actuate the rubbing style of the reproducing diaphragm without being themselves ironed out or distorted. The cutting action of the recording style is not that of a knife edge which merely enters the material and crowds it to one side, but is a true engraving action, whereby a portion of the tablet is removed in the form of chips or shaving to form the sound groove. The patent says that the essential new feature of the invention is the removal of the material to form the record by a cutting, gouging or engraving action of the vibrating style. Wax or a wax like composition was found to be peculiarly adapted for this purpose and the patent very clearly points out the conditions which controlled in the selection of this as a material for the tablet. On page 1 of the specification, lines 59 to 65, the inventors say :

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"The invention consists, secondly, in engraving or cutting the record in a waxy or amorphous and slightly cohesive substance, preferably, a compound of beeswax and paraffine (the latter in excess) is employed. This compound has no tendency to clog the style, but is readily removed thereby in chips or shavings."

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As I have before stated, the record groove is an exceedingly delicate, thread-like line, frequently not more than one one-thousandth of an inch in depth, and in order to guide the point of the reproducing style in this shallow groove, Bell and Tainter formed their groove with sloping walls, and then loosely mounted the reproducing style so that it can be readily guided by the record. The patent states this so clearly between lines 76 and 83, page 1, that I cannot do better than quote therefrom. It says:

"The invention consists, thirdly, in cutting or engraving a record in the form of a groove with sloping walls, the sound waves being represented by elevations and depressions at the bottom of the groove, or otherwise. The advantage of this form of record is that it forms an efficient guide to the reproducing style."

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That this part of the Bell and Tainter invention is not limited to a vertically undulatory groove, or to a groove formed in a tablet of wax or wax-like material, is clearly shown by the clause just quoted. So long as the record is cut or engraved "in the form of a groove with sloping walls," it is immaterial whether the sound-waves are represented therein by "elevations and depressions at the bottom of the groove" or are represented "otherwise" than by such elevations and depressions, as for example, by lateral undulations such as the zig-zag groove of the cross etched record. The essential requirement of this part of the invention is that the record shall be cut

or engraved in the form of a groove with sloping walls and the particular advantage being that this groove with sloping walls "forms an efficient guide to the reproducing style." As a means of enabling the reproducing style to be guided by the record, Bell and Tainter conceived the very ingenious idea of loosely mounting the style so that it was free to turn and adjust itself to and follow the record. The patent says, line 84, page 1, to line 3, p. 2:

"The invention consists, fourthly, in loosely mounting the reproducing style so that it can be readily guided by the record. Preferably the reproducing style, or rather what may be called the 'head' of the reproducing instrument, is mounted on an universal joint, and the style is pressed against the record by the yielding pressure of a spring or weight. Practically in instruments made by us, the pressure is due to the weight of the instrument modified by the elasticity of a section of soft rubber tube, which supports the same and constitutes a universal joint; but evidently there are many devices which can be used to mount the reproducer, so that it is free to follow the sound record, or phonogram, and which, *therefore*, would be within the scope of the invention.

The reproducing style, mounted as just explained, is specially adapted for use in connection with a record in the form of a groove with sloping walls, and this combination is specially claimed; but it may also be usefully employed in connection with other forms of record."

From what has heretofore been said it will be understood that all sound-records have two sorts of irregularities, viz., the undulations representing sound waves and those irregularities due to the impossibility of constructing machinery which shall be mathematically and theoretically true in every respect. Examples of this latter class of irregularity are found in a cylindrical record that

82 is not a true cylinder, a disk record that is warped from a true plane, and a spiral groove that is not a true spiral. Many others will readily suggest themselves. These irregularities of the second class, while minute, are very great as compared with those representing sound waves. It is necessary that the *diaphragm* of the reproducer should vibrate in response to irregularities of the *first* sort, and that it should *not vibrate at all* in response to the irregularities of the *second* sort.

83 The reproducing diaphragm is mounted or supported in a frame or head, and this frame or head must remain stationary in respect of the irregularities of the first sort (or those representing sound waves) but must respond perfectly to irregularities of the second sort or those due to inaccuracies of construction or variations in different machines in cases where the record is made on one machine and reproduced on another. This was a very difficult and unusual problem, but Bell and Tainter solved it by mounting the reproducer (that is the head with its supported diaphragm and style) on a universal joint and applying a yielding pressure in the form of a suitable spring or weight to the style to hold the same against the record. This yielding pressure may be secured and commonly is, by forming the reproducer head of such mass as to enable it to readily yield to the irregularities of construction, and at the same time possess an inertia so great that to the minute irregularities of the sound groove, it is immobile, thereby enabling all movements due to the latter form of irregularities to be impressed upon the diaphragm.

84 In the particular construction described in patent No. 341,214 in suit, the weight is modified by the elasticity of a section of soft rubber tubing, thereby utilizing the combined action of a spring and weight. This section of rubber tubing also performs another exceedingly useful function,

viz.: it constitutes a universal joint by means of which the loose mounting of the reproducer is secured. The object of thus loosely mounting the reproducer is not only to enable it to adjust itself to the irregularities of construction, which I have just mentioned, but is also *for the purpose of enabling the reproducer to be guided and moved by the record.* 85

After describing the construction and mode of mounting the reproducer the patent says, on page 4, lines 68-84:

"There exists always a liability to disarrangement in some part of the machine, either in the recorder or in the support therefor, or the recording tablet or its support, or if there be no disarrangement, it would be difficult to insure that the reproducing style should touch the record precisely at the proper point if the reproducer be held rigidly. Difficulties on these accounts are avoided by the loose or flexible mounting of the reproducer, the style automatically adjusting itself to the proper place on the record. It will be seen that the reproducer is mounted on a universal joint, so that it can move in any direction. The movement parallel with the face of the tablet would, however, by itself allow the style to follow and adjust itself to the record to a useful extent." 86

As is pointed out in the paragraph of the specification, which I have heretofore quoted, this loosely mounted reproducer is specially effective when used in connection with a record groove having sloping walls, because this form of groove is an efficient guide to carry the reproducing style along over the record. But Bell and Tainter were well aware that there were "other forms of record" (such as the Cros etched zig-zag record for example) which might usefully be employed to guide the reproducer across the record, as said reproducer turned on its universal joint, and they therefore pointed out that their invention of the univer- 87

88 sally-jointed or loosely mounted reproducer is not limited or confined in its employment to any particular form of record.

Another feature of improvement in the construction of the reproducer is accomplished by allowing the style to project beyond the edge of the supporting frame or head. Prior to the date of the Bell and Tainter invention, the diaphragm had been stretched across the frame or head as the diaphragm is on a drum, and the style was connected to the center of the diaphragm and projected therefrom at right angles to the plane thereof. The necessary result of this was that when the reproducer was placed with the style on the record, the style was covered by the diaphragm and head and its position could not be seen, thereby rendering it difficult to adjust it to any desired position on the record. To obviate this, Bell and Tainter formed "a reproducer or reproducing instrument in which the reproducing style, instead of being placed behind its support, projects at the point beyond the edge thereof." Besides allowing the position of the style to be observed this construction of reproducer with the style projecting from its edge is particularly useful in reproducing from that class of record which, like the Cros etched record, has lateral or zig-zag undulations.

When reproducing from such record the diaphragm is placed in a plane perpendicular to the plane of the record and consequently in order to enable the reproducing style to enter the record groove, it must project from the edge of the frame or head. Two forms of Bell and Tainter's reproducer with its projecting style are shown in Figs. 8 to 10 of the Patent No 341,214 in suit. The style 26 is clamped, riveted or cemented to the diaphragm 28 of Fig. 8, or 38 of Fig. 9, and it has its end projecting to enter the sound groove.

Adjourned by consent to Tuesday, March 28th, 1899, at 10:30 A. M.

Washington D. C., 91
March 28th, 1899.

Met pursuant to adjournment.

Present:

Parties as before.

Mr. Cameron continues his answer to question 5.

A further important improvement described in the patent is the mounting of the recorder so that it is held with yielding pressure against the surface of the tablet. As stated in lines 30 to 50 of page 2 of the specification this consists:

"In a sound recorder having a cutting or graving style which is held by elastic or yielding pressure against the surface on which the record is to be made. The object is to enable the vibratory graver or cutting style to ride over instead of ploughing through any elevations on the recording surface. The depth to which the point of the cutting style is *embedded in the record* affects the amplitude of the styles vibration. By this improvement the depth is kept uniform, notwithstanding any slight unevenness of the recording surface."

By the construction here described provision is made by means of which the recorder is enabled to perform its functions without being affected by the irregularities such as the unevenness of the recording surface to which I have referred in connection with the reproducer. One method of securing this yielding action of the recorder or reproducer is to have the recorder or reproducer, as the case may be, rest against the tablet by *gravity*. The action of the recording style in cutting or engraving a record groove is controlled

94 entirely by the force of the sound waves impinging upon the diaphragm of the recorder, and since the resistance to the cutting action increases very rapidly with any increase in the depth of the cut, the action of the style would meet an undue, and, in fact, a fatal resistance to recording action if it were allowed to plough through any uneven portions of the record.

For example, if a cylindrical tablet were slightly eccentric, say even to the one thousandth part of an inch, or if the action of the temperature upon the material of the tablet was such as to cause it to expand or contract unevenly, though but in the slightest degree, and if the recorder were clamped or otherwise held rigidly in position, it will be perceived that the groove cut by the style in the cylinder would offer a varying resistance to the action of the style, and that, in portions of the cylinder, the style would have imposed upon it a much greater amount of work to perform than the feeble power of the sound waves would be able to accomplish. This being the case, it will be readily understood that the successful cutting of a sound record depended upon the discovery of some means whereby the resistance to cutting action of the style might be rendered uniform, and as a matter of fact, I understand that it was not until the
95 gravity-controlled or floating recorder and reproducer had been invented that Bell and Tainter carried the idea of forming an engraved record to a successful conclusion, notwithstanding the fact that they had experimented with a cut or engraved record prior to the invention of the yielding or gravity-controlled recorder and reproducer. This construction has become known in the art as the
96 "floating" or "gravity" recorder or reproducer. The term "floating" is a peculiarly apt one in this connection as the recorder or reproducer, as the case may be, rises and falls upon the surface of the record

just a block of wood rises and falls upon the surface of the water, the block conforming at all times to the varying plane of the surface of the water while remaining always in contact therewith. The result of this floating action of the recorder or reproducer is that any unevenness in the surface of the record will not affect the perfect operation of either the recorder in making the sound grove, or the reproducer when in the act of reproducing the sound. This perfect mobility of the reproducer as a whole to the unevenness and irregularities of the record tablet while remaining rigid and entirely unaffected by the minute undulations of the sound-groove which cause the vibrations of the diaphragm, is absolutely essential to any practical talking machine. The floating reproducer is essential to successful reproduction from a record engraved in the wax or wax-like material, *but a record groove engraved in wax or wax-like material is not essential to the successful operation of the floating reproducer.* This form of reproducer is also highly advantageous when operating in conjunction with a laterally undulating or zig-zag record, etched in metal or otherwise formed in suitable resisting material, because in such forms of record there are the same irregularities of construction, such as warping, changes due to temperature and variations due to forming a record on one machine and reproducing it in different relations, which are common in records cut or engraved in wax or wax-like material. The immense value of this floating reproducer in the art of recording and reproducing sounds will be best appreciated by remembering that there is not a practical talking machine known in the world to-day that does not use it, and prior to its invention by Bell & Tainter, there is not a known example of its use. This beautiful conception, whereby Bell & Tainter allow the reproducer head with its supported diaphragm to

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100 smoothly float over irregularities of the tablet surface while still holding the diaphragm in position to respond accurately to the undulations of the sound groove, was embodied in the universally jointed reproducer, and removed at one stroke many of the difficulties theretofore experienced in this art. I would name as some of the important advantages secured thereby:

(1) That it wholly did away with the necessity for expert and accurate adjustment of the reproducer by the operator. The universally mounted or floating reproducer automatically adjusts itself.

101 (2) It maintains the reproducing style and diaphragm in ideal relation with the undulations of the sound-groove notwithstanding any unevenness or irregularities in the tablet surface of other parts of the machine.

(3) It enables the reproducer to be guided and carried along by the sound-groove, so that the reproducer is free to follow the same and move across the record in a line parallel with the surface thereof.

102 Prior to the Bell and Tainter invention described in patent No. 341,214 in suit a sound record had, so far as I am aware, never been made upon one machine and removed therefrom and reproduced upon another and different machine; nor had any machine been devised whereby a record could be removed therefrom and replaced at will thereon for reproduction. For the first time in the history of the art patent No. 341,214 disclosed a removable sound record. This was an advance step of vast importance. It made it possible for one person to make a record, remove it from a machine and send it by mail or otherwise to another person at a distance who could place it on a similar machine and reproduce it. The feature of a removable

sound record lies at the foundation of the immense trade in sound records that has sprung up since the date of the Bell and Tainter patent. Without this feature of the removable record, it is manifest that the commercial field open to talking machines would be so limited as to be of little value, whereas with the removable record correspondence can be carried on by mail between two persons having similar machines, and dramatic, musical and other productions can be recorded and the records sold for purposes of instruction and amusement. In this latter branch alone there are hundreds of thousands of dollars expended annually. And yet valuable as the removable record is in this art, essential as it is to the commercial practice of the art, such removable record would be practically impossible without the employment of the floating or gravity reproducer. It would not be possible to construct commercial machines with such accuracy as to enable the record to be accurately and successfully reproduced on any one of them without the employment of this floating reproducer. In short, while the removable record is an absolute necessity in the commercial practice of the art, such record would be utterly valueless in the absence of the floating or gravity reproducer.

There are other details of improvement over the prior art mentioned in the Bell and Tainter patent in suit, but as they do not relate particularly to the reproducing devices to which your question is specifically directed, I have not mentioned them in connection with such devices.

Q6. Have you read and do you understand the construction and operation of the mechanism described in "Complainant's Exhibit Patent No. 341,288 in suit?"

A. I have read and understand the patent referred to.

Q7. Please state what, if any improvements in

106 the reproducing devices you find described in said patent, with particular reference to Claim 44 thereof.

A. The reproducer defined in Claim 44 of the patent mentioned is best shown in Figs. 12 and 15 of Sheet 5 of the drawing, the latter figure affording a very clear illustration of the construction defined by the claim. Rigidly secured at one end to the frame or head of the reproducer is a flat spring 359. This spring has a style, 382 of Fig. 15, secured to it on one side, while the other side of the spring is in connection with the diaphragm 362 through the metal button 284. As the point
107 of the style is vibrated by the undulations of the sound groove, the spring 359 by bending in and out transmits the vibrations through the rigid connections 384 to the diaphragm, the spring serving as a sort of elastic hinge to unite the style to the frame, and the button serving as the transmitting medium between the spring and diaphragm.

In the patent the particular form of record shown is one with undulations perpendicular to the plane of the surface, and the particular form of reproducer shown is designed for use with records of this character, the point of the style being located approximately opposite the center of the diaphragm, but it is manifest that the same
108 principle of mounting the style on the frame with a yielding connection through which the vibrations of the style are transmitted to the diaphragm, may be applied to a reproducer having the style point projecting beyond the edge of the frame after the manner shown in Figures 7 and 9 of the Bell and Tainter patent No. 341,214 in suit, and that a style so projecting may be used in connection with either a vertically undulating sound groove of the kind described in the Bell and Tainter patent No. 341,214 in suit, or with a zig-zag or laterally undulating sound groove, such as the etched record groove described in the French

patent to Cros, to which I have heretofore referred. 109
That the illustration and description contained in patent No. 341,288 in suit were merely intended to illustrate the inventive idea without defining the limits of the invention is very clear, as the patent states, in line 57 to 67, page 9, that "in the foregoing description of the machine shown in the drawings, dimensions, proportions, materials and other details of construction are mentioned with particularity for the purpose of enabling others more readily to make and use the new improvement, and not as limitations of the said improvements, since it is obvious that modifications can be made in detail without departing from the spirit of the invention, and that parts of the invention can be used separately". 110

From this it is apparent that mere modifications in details, which still preserve the spirit of the invention, were clearly contemplated by Prof. Tainter, and Claim 44, to which you particularly call my attention, is evidently phrased with the same idea, *i. e.*, that the invention is broader in scope than the particular form of reproducer shown and described in the patent. This claim is as follows:

"44. The combination, with the reproducer style and the diaphragm or device upon which the reproduced sonorous vibrations are to be impressed by said style, of a flat metal spring 111
interposed between the style and diaphragm and forming a yielding connection, through which the reproduced vibrations are transmitted, said spring having a practically rigid connection with the diaphragm, substantially as described."

For the reasons given, I understand the terms of this claim are clearly intended to include any form of reproducer which has a spring upon which the reproducer style is supported and which spring has rigid connections between it and the diaphragm, so that the spring forms a yielding connection or elastic hinge through which the vibrations of the

112 style are transmitted to the diaphragm, and this of course includes not only the form of reproducer with the style projecting beyond the edge of the frame but the form with the style point opposite the face of the diaphragm as well.

Q8. Have you read and do you understand the mechanism described in "Complainant's Exhibit Patent No. 375,579 in suit," and if so please state what improvement in the reproducing devices you find therein having reference particularly to Claim 20?

A. I have read and understand the Patent No. 375,579 to Tainter referred to in your question.
113 That portion of the mechanism to which your question particularly relates, viz., the reproducer, is best illustrated in Fig. V of the drawing which shows a reproducing diaphragm 90 mounted in a suitable frame and connected to one arm of a lever 93, the other arm of which is in contact with and is vibrated by the undulations of a sound groove. The lever is in this instance shown as connected to the diaphragm by a thread 94, and is mounted to turn on its fulcrum 970, so that the vibrations imparted to the style point by undulations in the sound groove will be transmitted through the connecting thread to the diaphragm. One of the great advantages secured by thus forming the
114 style as a two-armed *lever* turning on a fulcrum with one arm connected to the rubbing point which passes over the undulations of the sound groove, is that it is thereby rendered possible to *regulate the amplitude of vibration of the diaphragm relatively to the amplitude of the undulations of the sound groove*. Thus, if it is desired that the amplitude of vibration of the diaphragm shall be equal to that of the undulations of the sound groove, the two arms of the lever will be made of equal length. On the other hand if it be desired that the amplitude of vibration of the diaphragm shall exceed that of the record undulations, the

arm of the lever connected to the diaphragm is made longer than the arm bearing the rubbing point; while if it is wished to have the amplitude of vibration of the diaphragm less than that of the record undulations, then the arm of the lever which is connected to the diaphragm is made shorter than the arm bearing the rubbing point. 115

Thus the patent says, lines 98 to 105, page 5:

"One advantage of using a lever as the reproducing style is that by making the inner arm shorter than the outer, as shown in the drawings, the motion of the diaphragm can be reduced, which, though it involves a slight loss in loudness, is found to produce a more than compensating gain in distinctness of enunciation." 116

The converse of this statement is equally true. That is by making the inner arm of the lever longer than the outer the amplitude of vibration of the diaphragm can be increased, which would involve a gain in loudness of the reproduced sounds, but doubtless with a loss in distinctness.

Claim 20 does not state specifically any one of the three constructions which I have just described; it does not state what the relative lengths of the arms of the lever are, but is phrased in terms broad enough to include all of them.

It reads:

"20. The combination with the diaphragm of the reproducer of the rubbing style consisting of a lever having the rubber point formed on one arm and the other connected with said diaphragm, substantially as described." 117

In view of the wording of this claim and of the statement in the specification that "it is obvious that modifications may be made without departing from the spirit of the invention," I do not regard the particular kind of lever, or character of connection between such lever and the diaphragm, as at all material. Thus, a bell crank lever is

118 shown in the drawing of the patent, and a thread connection is shown between the lever and the diaphragm, but I should regard a straight lever, one arm of which was connected to the diaphragm either by a thread or directly connected thereto by cement or otherwise, as being clearly included in the terms of this claim.

Q9. Do you understand the construction and mode of operation of "Complainant's Exhibit Defendants' Machine" and "Complainant's Exhibit Defendants' Sound Record?" If so please explain the same.

119 A. I have carefully and repeatedly examined the machine and record to which your question refers and am thoroughly familiar with the construction and mode of operation of the same. The record is of the disk form having upon one of its sides a spiral sound groove of even depth whose undulations are parallel with the surface of the tablet, that is, it is the zig-zag type of record which Cros described in his French Patent of 1878 as being the type which he preferred. I observe that it is marked "E. Berliner's Gramophone, Patented Nov. 8, 1887, May 15, 1888, May 6, 1890, Feb. 19, 1895, Oct. 29, 1895, other patents applied for," and I find these dates to be those upon which the following United States Patents were granted to
120 E. Berliner, viz.:

No. 372,786, dated November 8th, 1887,

382,790, " May 15th, 1888,

427,279, " " 6th, 1890,

(E. Berliner, assignee of Suess)

534,543, dated Feb. 19, 1895,

548,623, " October 29th, 1895.

I have carefully read these patents and also a pamphlet entitled "Paper read before the Franklin Institute, May 16, 1888, on the Gramophone, by its inventor, Emile Berliner," and "Published by the United States Gramophone Company, Wash-

ington, D. C." Mr. Berliner's Patent No. 372,786 sets out a process of forming a sound record which consists in forming by means of a phonautographic apparatus a record upon a travelling layer of lamp-black, then transferring this phonautographic record by photoengraving upon metal, which metallic record was to be used for reproducing. 121

This is exactly the method described by Cros in his French Patent and Mr. Berliner, after filing the application upon which his patent of November 8th, 1887, No. 372,786, was granted, discovered that Cros had anticipated him by about ten years, and he, Berliner, thereupon discarded that method for another, described in his patent of May 15th, 1888, No. 382,790, which method consists in producing a phonautographic record through a film of beeswax or paraffine (instead of lamp black) on a metallic surface, and then subjecting the metal, where it was exposed along the lines of the record to the action of an etching acid. This precise method was also disclosed in the French patent to Cros wherein it is said: 122

"The lamp black can be replaced by a body insulating an underlying metallic plate from the engraving action of an acid."

Cros mentioned paraffine as an example of the insulating material with which to cover the metallic plate, to form the etching ground, and Berliner in his said patent No. 382,790 simply followed the directions given ten years before by Cros in his French patent No. 124,213, that is, he covered a plate with a thin coating of film of some substance such as paraffine and then traced a phonautographic or transversely undulating zig-zag record through this film, thus exposing the plate along the zig-zag line, and then applied a suitable acid which would not attack the paraffine film, but did etch or eat out the plate where it was exposed 123

124 along the ziz-zag line; in other words he followed the ordinary, and at that time well known, process of etching. This gave him a record etched in the metal plate, the same being precisely the record which was secured under the French patent to Cros above referred to. Claim 1 of Berliner's Patent No. 382,711 is as follows:

125 "1. The method or process of producing a record of sound-waves in solid resisting material for reproduction of the recorded sounds, which consists in covering the surface of such material with a film of etching ground that offers no perceptible mechanical resistance, then making a phonautographic record upon and through the etching ground, and then exposing the record to the action of a suitable etching agent, substantially as described."

This is a precise statement of the method described by Cros in his French patent with the single exception that the material for the etching ground is described as offering no perceptible mechanical resistance, but inasmuch as the Cros Patent mentions paraffine as an example of the insulating material, and Berliner also mentions paraffine as an example of the material forming his etching ground, the particular expression used to define that material in the claim is unimportant.

126 It is only conceivable that this claim, as well as some of the other claims of this patent, could have passed the scrutiny of the examiners in the Patent Office, because, as Mr. Berliner says in his Franklin Institute paper mentioned above, "not even the examiners at the Patent office knew anything of Mr. Cros." In this connection I note that in the Franklin Institute paper Mr. Berliner acknowledges Cros as the originator of the lamp-black photoengraving method which he, Berliner, knew to be impracticable, but he says nothing about Mr. Cros in connection with the etching method.

In his patent No. 548,623 of October 29th, 1895, Mr. Berliner describes a method of duplicating in

hard rubber the records etched in metal by the process set forth in the patent No. 382,790, that is, the Cros process as set out in French Patent No. 124,213. This method of duplication consists in forming a copy of the etched record in relief or reverse, and then using this copy as a stamp or die to secure an impression in hard rubber, the latter being softened by heat for the purpose. 127

As the record "Complainant's Exhibit, Defendant's Record" is made on a disk of what appears to be hard rubber, and as it is made under the patents of May 15th, 1888, May 6th, 1890, and October 29th, 1895, and as I have examined the same under a microscope and find it to have upon its face a transversely undulating or zig-zag spiral line, which, when acting in conjunction with a reproducer, produces sound; I have no hesitation in saying that the same is a sound record stamped in a hard rubber tablet by a reverse or relief copy of a zig zag record etched in metal by substantially the method described by Cros in his French Patent No. 124,213 of 1878. 128

In other words, it does not differ from the record of the Cros patent in any particular other than that it is formed in a rubber instead of a metal disk, and this is merely for the purpose of affording a cheap means of duplication and does not produce any change either in character or function. From this it will be clear that more than ten years prior to Berliner, Crös had told the world how to etch exactly this record in metal. It does not appear that Cros ever actually constructed any means whereby he could reproduce sound from his record. In fact, it was not until Bell and Tainter invented their loosely mounted or floating reproducer some years later that a commercially practical reproducer was known. Upon carefully examining Complainant's Exhibit, Defendants' Sound Record under a microscope, I find that the spiral sound-groove thereon has sloping walls; that is, the 129

130 groove in cross section is V-shaped, with the point of the V slightly rounded. It is therefore the kind of a sound-groove for which Bell and Tainter described their loosely mounted or floating reproducer as being specially adapted. In lines 101, page 1, to line 3, page 2, of the Patent No. 341,214, in suit, it is stated:

"The reproducing style mounted as just explained is specially adapted for use in connection with a record in the form of a groove with sloping walls, and this combination is specially claimed; but it may also be usefully employed in connection with other forms of record."

131 At the time of filing their application for Patent No. 341,214, in suit, Bell and Tainter were undoubtedly acquainted with the various forms of record, the Edison indented, the Cros etched and their own engraved record, and the sentence which I have just quoted very clearly shows that they fully appreciated the value of the floating reproducer when used with "other forms of record" than their engraved form. I have carefully observed the action of the reproducing style on Complainant's Exhibit, Defendants' Machine in conjunction with the sound-groove of Complainant's Exhibit, Defendants' Sound Record, and have
132 studied the action of the same under the microscope. I find that the grooves are exceedingly fine and thread-like and quite shallow, and that notwithstanding the fact that the reproducer point seems sharp to the touch, that it is, when compared with the thread-like groove of the record quite blunt. When the point of the style rests in the groove it travels along the bottom thereof, fully filling the groove and contacts at all times with the walls of the grooves on both sides, that is, the style does not move back and forth across the groove, but fits snugly therein so that the sloping walls of the

groove act simultaneously on the opposite sides of the style point and guide the same. I have also observed that notwithstanding the fact that the sound grooves themselves are considerably narrower than the lands or spaces between the grooves, that it is unnecessary when starting the machine to use any care when placing the style upon the record to adjust the style point within the sound groove, as the same will speedily approach the edge of such groove and at once gravitate down the sloping side thereof until it assumes the proper adjustment in the groove, after which the groove guides the reproducing point and by reason of the universal mounting of the reproducer the groove with its sloping walls compels this reproducer to follow the groove.

“Complainant's Exhibit, Defendants' Machine” consists of a revolving table supporting the record (the table being driven by a clock-work motor), the machine being provided with a loosely mounted reproducer resting by gravity upon the record. The reproducer proper (that is the frame or head with its supported style and diaphragm) is carried at one end of a wooden arm which is connected to the frame of the machine by a universal joint. This construction is shown in Fig. 1 of U. S. patent No. 427,279, May 6th, 1890, issued to Emile Berliner as the assignee of Werner Suess, in which patent it is stated that this mounting constitutes a universal joint and is so arranged that the stylus rests lightly but with sufficient pressure on the tablet with its point in the record groove, and that reliance is placed upon this control of the stylus by the walls of the record groove for the movement of the stylus across the face of the disk; or as it is stated in Berliner's Patent No. 534,543 (where this construction is shown in Fig. 3):

“The rotating record groove will *guide the stylus* across the face of the tablet.”
(The italics are mine).

136 When "Complainant's Exhibit Defendant's Record" operates in combination with "Complainant's Exhibit Defendant's Machine" there is a record groove with sloping walls which forms an efficient guide to the reproducing style combined with a reproducer loosely mounted so that it can readily be guided by the record, that is, it constitutes precisely the invention set forth in the third and fourth paragraphs of the statement of invention in the Bell and Tainter Patent No. 341,214 in suit.

137 Referring more particularly to the specific construction of the reproducer, I find that it consists of a metallic frame or head having a diaphragm, apparently of ising-glass, secured therein, and a flat metal spring secured at one end to the frame of the reproducer and having a rigid connection with the diaphragm, the spring also having the style connected to it by a set screw, which style projects outside of or beyond the edge of the instrument. Furthermore, the style point (when retained in place by the set screw constitutes, with the arm rigidly connecting the flat spring to the diaphragm), constitutes a lever having a rubbing point formed on one arm and the other arm connected with the diaphragm. The arm which is connected to the diaphragm is longer than the arm having the stylus point. 138 The result of this will be that any vibration of the stylus point will cause a vibration of greater amplitude in the diaphragm. As I have before explained, such a construction would have a tendency to increase the loudness of the reproduced sounds, but at the expense of the purity of quality, and by placing this reproducer on defendant's machine with defendant's record, I find the resulting reproduced sounds to be quite loud but exceedingly harsh and disagreeable to the ear.

Adjourned by consent to Wednesday, March 29th, 1899, at 10 A. M.

Washington, D. C.,

139

March 29, 1899.

Met pursuant to adjournment.

Present: Parties as before.

Q10. Please state whether or not you find the constructions defined in any of the claims of the patent No. 341,214 in suit embodied in "Complainant's Exhibit Defendants' Machine," or "Complainant's Exhibit Defendants' Record," and, if so, please indicate the particular claims, giving your reasons for any conclusions you may reach?

A. I find in the machine referred to the construction defined in Claims 19, 20, 21 and 25 of patent No. 341,214 in suit, and when said machine is combined with defendant's record, I also find the construction defined in Claims 22 and 23 of said patent. 140

For the sake of clearness I will consider these claims one at a time and point out the features in defendants' machine and record which respond to the demands of each claim.

Claim 19 reads as follows:

"19. The combination, with a reproducing style of a mounting therefor, which leaves said style face to move laterally and thereby adjust itself automatically to a sound record, substantially is described." 141

I note that this claim uses the expression "style *face* to move laterally," but I find upon inspection of the original specification in the files of the Patent Office that this should be "style *free* to move laterally."

Turning now to defendants' machine I find that it has a reproducing style, which is the metal point resting upon the record; I find this style combined with a mounting, which is the reproducer head and the long wooden arm supporting it; and upon operating the machine with defend-

142 ants' record thereon I find that this mounting is such that it leaves the style free to move laterally by reason of the turning of the wooden arm upon its vertical pivot pin, and that as a consequence the style automatically adjusts itself to the record. I have repeatedly demonstrated that the mounting of the reproducing style in defendants' machine is such as to leave the style free to move laterally, and that by such movement it adjusts itself automatically to the record. I have many times placed the style carelessly upon the record, using no effort whatever to adjust it thereon, and upon starting the machine the style invariably adjusted itself automatically to the record as perfectly as if the utmost care had been exercised. I have removed one record and placed another upon the machine without any effort at adjustment, and always with the same result, the style shifts laterally and automatically adjusts itself to the record.

143 There are but two elements mentioned in the claim, viz., the reproducing style and the mounting therefor. Both of these elements are found in defendants' machine, and when combined they operate precisely in accordance with the terms of the claim. I am not unmindful of the fact that the wooden arm constituting the mounting for the reproducing style in defendants' machine is longer than that shown in the Bell and Tainter patent, but I fail to find in the description of the patent, or in the terms of the claim, anything whatever limiting the invention to any particular length of arm, and inasmuch as the function of the style thus mounted is precisely the same in defendants' machine as in the construction shown in the patent, I do not regard the matter of the length of the wooden arm in defendants' machine as of any importance whatever.

144 I have no hesitation, therefore, in stating that I find in Complainant's Exhibit Defendants' Ma-

chine the precise combination, operating in the identical manner defined in said Claim 19 of the Patent No. 341,214 in suit. 145

Claim 20 reads:

"20. The reproducer loosely mounted on a suitable support, so that the reproducing style is capable of a lateral movement and may in consequence thereof adjust itself automatically on the record, substantially as described."

I find in defendants' machine a reproducer, which is the metallic frame or head together with its supported diaphragm and style; I find this reproducer mounted on a suitable support which support is the metallic arm extending out from the side of the box enclosing the motor; furthermore, I find that the reproducer is loosely mounted through the medium of the wooden arm pivoted upon said support so that the reproducer is capable of a lateral movement, and that as a consequence of such capacity for lateral movement the reproducing style is free to and does automatically adjust itself on the record. The loose mounting whereby the reproducing style is enabled to move laterally consists, as I have stated above, in the long wooden arm carrying the reproducer and swinging in a horizontal plane around its pivot pin bearing in a socket on the outwardly extending metallic arm or support. When defendants' record is placed on the machine and the reproducing style allowed to rest on the record, if the style point falls on one of the lands or ridges between the sound grooves, rather than within one of the grooves, on revolving the record the style immediately shifts laterally thus adjusting itself on the record. Moreover, I notice that this capacity for lateral movement not only enables the style to adjust itself to the record groove, but that the style "follows" the record groove from the outer- 146 147

148 most to the innermost spiral thereof, thus doing precisely the two things which Bell and Tainter say in their description this freedom of lateral movement for the style is designed to do, that is, permits the style to "*adjust* itself to the record," and then *follow* the record. The specification says "the reproducer * * * in consequence of the flexibility of the rubber tubing 32 is free to follow the record" (page 4, lines 57 to 62).

149 I do not overlook the fact that in the construction shown in the Bell and Tainter patent, means are provided whereby the record is not only revolved but is also intended to be given a movement in a straight line past the reproducing style, while in defendants' machine the record is only revolved and the style point is moved across the record in an arc which approximates a straight line. I do not, however, regard the patent as limited to a construction wherein the record has this rectilinear movement. The specification expressly states that "it is evident that various modifications other than those indicated can be made and the invention still be employed in whole or in part, and also that parts of the invention can be used separately" (page 6, lines 42-47).

150 And the specification further points out that there is a liability to disarrangement whereby the record will not have this movement, and explains that in such or similar cases the capability of free lateral movement which the style has by reason of its loose mounting will enable it to *follow* the record as well as adjust itself thereto.

The patent says, page 4, lines 68-84:

"There exists always a liability to disarrangement in some part of the machine either in the recorder or the support therefor or the recording tablet or its support, or if there be no disarrangement it will be difficult to insure that the reproducing style should touch the record precisely at the proper point if the reproducer be held rigidly. Difficulties on

these accounts are avoided by the loose or flexible mounting of the reproducer, the style automatically adjusting itself to the proper place on the record. It will be seen that the reproducer is mounted on a universal joint so that it can move in any direction. *The movement parallel with the face of the tablet would, however, by itself allow the style to follow and adjust itself to the record to a useful extent.*" (Italics mine.) 151

It is apparent, therefore, that the freedom of lateral movement possessed by the reproducer with its supported style in defendants' machine, confers upon such reproducer and style precisely the functions which the patent pointed out as resulting from the loose mounting and free lateral movement defined in Claim 20. 152

For the reasons given I am of the opinion that the exact construction defined in Claim 20 is found in Complainant's Exhibit Defendants' Machine.

The 21st claim reads:

"21. The reproducer mounted on a universal joint and held against the record by yielding pressure, substantially as described."

As I have before pointed out, I find in defendants' machine a reproducer, which is a metallic frame or head with its supported diaphragm and style point, such reproducer being carried by the long wooden arm, which arm is mounted at its outer end on the outwardly extending metallic arm by means of the vertical and horizontal pivots constituting a universal joint therefor. When defendants' record is placed upon the machine and the reproducer put in position to co-operate therewith, the reproducer is held against the record by the yielding pressure due to its own weight, or as the patent No. 427,279, granted to Berliner as the assignee of Sness, defines the action of this construction "the stylus rests lightly, but with sufficient pressure, on the tablet with its point in the 153

154 record groove." The reproducer is free to rise and fall in response to any irregularities (such as warping of the record), without in any way interfering with the contact between the style point and the undulations of the sound groove. In short, it is a gravity or floating reproducer. I have demonstrated this repeatedly by placing a badly warped record on the machine in conjunction with the reproducer and have found that the latter rises and falls with the warped surface of the record, yielding to the inequalities or irregularities due to the warping, without once withdrawing the style from the groove, exactly as a cork would rise and fall with the waves of the sea. Very clearly then the construction defined by claim 21 is embodied in
155 defendants' machine.

I Quote claim 22:

"22. The combination, with a grooved tablet or other body having a sound record formed therein, of a reproducer having a rubbing style loosely mounted, so that it is free to move laterally and thus adjust itself to the groove, substantially as described."

When defendants' record is employed, as it is intended to be upon defendants' machine, I find a grooved tablet having a sound record formed therein; I find a reproducer having a style rubbing
156 in said groove, and, as I have explained in connection with claim 20 this style is loosely mounted so that it is free to move laterally and thus adjust itself to the groove. Each element of claim 22 having the identical construction defined by the claim, is found in defendants' combined machine and record, and the elements so co-act in exact accord with the terms of the claim. Clearly, therefore, the construction defined by claim 22 is found in defendants' combined machine and record.

Claim 23 is as follows:

"23. The combination, with the tablet or other body having the sound record formed

therein as an irregular groove with sloping walls, of a reproducer having a style for rubbing over said record, and mounted on a universal joint, substantially as described." 157

In Complainant's Exhibit Defendants' Record mounted upon and operating with Complainant's Exhibit Defendants' Machine I find the combination of a tablet, which tablet has a sound record formed therein, as I have demonstrated by operating the machine and obtaining reproductions of sounds therefrom.

Such record is in the form of a groove, which groove upon inspection I find to be irregular in character, that is, it is a spiral groove with irregularities or zig-zag-sinuities corresponding to sound-waves, and upon carefully inspecting such groove under a microscope I find, as I have heretofore stated, that the walls of the groove slope toward each other so that in cross-section it is of V-shape with the bottom or point of the V slightly rounded. I find therefore a tablet having a sound-record formed therein as an irregular groove with sloping walls as demanded by claim 23. As I have pointed out in connection with claims 19, 20 and 21, the reproducer of Defendants' Machine is mounted on a universal joint, and I find that upon operating the machine in conjunction with the sound-record constructed as I have just described, the style of such reproducer rubs over the record as demanded by said claim 23. 158 159

I have heretofore pointed out that this sound groove with sloping walls, as found in Defendants' Record, does exactly what the inventors Bell and Tainter point out in their patent in suit that it is intended to do, that is it "forms an efficient guide to the reproducing style." Not only do my own experience and observation with defendants' record prove that its groove with sloping walls forms an efficient guide for the reproducing style, but I find that Mr. Berliner himself states in his

160 U. S. patent No. 534,543 (page 5, lines 25, 26)
that "the rotating record groove will *guide the stylus.*"

I find therefore that when Defendants' Machine is operating in combination with Defendants' Record it embodies a tablet having a sound record formed therein as an irregular groove with sloping walls with a reproducer having a style for rubbing over said record and mounted on a universal joint as demanded by claim 23.

Claim 25 reads:

161 "25. A reproducer having a style projecting beyond the edge or end of the instrument so that the position of the point of the style on the record may be readily seen, substantially as described."

The style in the reproducer of Defendants' Machine is attached to the frame or head of the instrument so as to project beyond the edge thereof, to the extent of about half an inch, being secured to the frame by means of a small set screw. By reason of this projection beyond the edge of the instrument the position of the style on the record may be readily observed. Clearly then the construction defined in claim 25, viz., a reproducer having a style projecting beyond the edge of the instrument, is found in defendant's machine.

162 Q11. Please state whether or not you find the construction defined in claim 44 of the Tainter Patent No. 341,288, in suit embodied in defendants' machine, giving your reasons for your conclusions?

A. Claim 44 of the patent referred to reads as follows:

"44. The combination, with the reproducer style and a diaphragm or device upon which the reproduced sonorous vibrations are to be impressed by said style, of a flat metal spring interposed between the style and diaphragm and forming a yielding connection, through

which the reproduced vibrations are transmitted, said spring having a practically rigid connection with the diaphragm, substantially as described." 163

I have heretofore explained that defendants' machine has a flat spring attached to the side of the reproducer frame, and that the style is secured on one side of said spring, the other side of which spring has a rigid connection with the diaphragm through an arm which is united to the spring and cemented to the diaphragm. By means of this construction the spring forms a yielding connection through which the vibrations of the style are transmitted to the diaphragm.

Claim 44 has four elements, the reproducer style, the diaphragm, the flat metal spring interposed between the style and diaphragm, and the rigid connection between the spring and diaphragm. I find these four elements in the reproducer of defendants' machine arranged and co-acting in precisely the manner defined by claim 24, and I therefore find in defendants' machine the construction defined by said claim. 164

Q12. Please state whether or not you find the construction defined in Claim 20 of the patent to Tainter, No. 375,579, in suit embodied in defendants' machine, and if so, please give your reasons for your opinion? 165

A. Claim 20 of Patent No. 375,579 in suit is as follows:

"20. The combination, with the diaphragm of the reproducer, of the rubbing style, consisting of a lever having the rubbing point formed on one arm and the other connected with said diaphragm substantially as described."

The reproducer of defendants' machine has a diaphragm which is combined with a lever fulcrumed on the flat spring attached to the side of the reproducer, the longer arm of the lever having

166 its end cemented to the diaphragm and the shorter arm having a rubbing style point projecting beyond the edge of the frame of the reproducer. As this is the identical construction defined in Claim 20 above quoted, I find in defendants' machine the construction defined in said claim.

Adjourned subject to agreement between counsel.

Washington, D. C.,
May 30th, 1899.

167 Met pursuant to agreement at the offices of Philip Mauro, Esq., No. 620 F street, Washington, D. C.

Present:

PHILIP MAURO, Esq., for Complainant.
JOSEPH LYONS, Esq., for Defendants.

Cross-examination of MR. CAMERON by Mr. Lyons:

168 XQ13. Have you, since giving your direct testimony, read the record of the same, and, if so, have you now to make any correction in your testimony?

A. I have proof-read a type-written copy of my direct testimony, and, unless it be in some mere typographical errors, I know of no corrections which I desire to make.

XQ14. Will you please refer to Patent No. 341,214, to Bell and Tainter, which is here in suit, and state whether or no the word "record" appears in the said patent for the first time on page 1, line 16, in the connection as follows:

"The invention consists, first, in the formation of the record or 'phonogram,' as it has

been called, by means of a cutting style, which is vibrated by the sound waves or sonorous vibrations to be recorded?" 169

A. You have quoted the patent correctly, and the word "record" appears as stated in said line 16 for the first time in the specification.

XQ15. From the passage in the specification that I have quoted in the preceding question, it would appear that the "record" is the result of an operation of a "cutting style." Am I correct?

A. The record is the result of the operation of a cutting style in combination with a suitable blank or tablet. 170

XQ16. So that if there be no cutting style there would be no record, so far as the passage I have quoted from the specification shows?

A. The passage quoted refers to a record in the formation of which a cutting style is essential.

XQ17. Then the cutting style produces in the solid substance elevations and depressions, for other inequalities, so far as I can gather from the second paragraph of the specification. Is this correct?

A. It is.

XQ18. Would it not follow from this that the "record" referred to in the passage which I have quoted in XQ14 consist of "elevations and depressions," or other inequalities? 171

A. I should rather say that the record consists "in a solid substance," having "elevations and depressions or other inequalities" formed therein.

XQ19. You have said that in the formation of a record a cutting style is essential. Will you now say whether or no a record, such as is spoken of in the specification, is the creation or the product of a suitably-actuated cutting style?

A. In the first place, I have not stated that in the formation of a record a cutting style is es-

172 sential; I have limited that statement to the particular record referred to in the clause beginning at line 15, page 1 of the specification. If, however, your question refers to such a record, I will state again that such record is the product of a suitably actuated cutting style when acting in combination with a suitable tablet or solid substance.

XQ20. You have not yet stated whether or no a record such as is referred to in the passage of the specification quoted in XQ14, is the creation or the product of the work of a suitably actuated cutting style. I should like to have a definite answer to this question, and there would seem to be no difficulty in answering it categorically?

A. I have answered the question in as distinct a manner as I know how. The record referred to in the paragraph quoted is the result of the co-operation of the cutting style with the tablet or solid substance; each is essential to the formation of the record.

XQ21. What does the cutting style do with the solid substance or tablet?

A. If the tablet has suitable motion imparted to it the cutting style cuts the tablet. If, however, the tablet remains stationary the cutting style will do nothing.

174 XQ22. That seems to be very plain; however, we are here, assuming that the cutting style is doing what the specification says that it does. In that case you say that it cuts the tablet. Will you please state what kind of cut it produces on the tablet?

A. In the absence of sound waves the style would cut a groove in the tablet, provided it was brought into contact or as the specification states had its point embedded in the surface thereof, and provided there were relative movement between the style and the solid substance, constituting the tablet. I may add that I am assuming

in answering this question, and have assumed in the previous answers, that the style is brought in-
to contact with a substance sufficiently soft to permit a style to cut or otherwise act thereon. If the style had its point imbedded in the surface of a tablet composed of a suitable solid substance, as for example one of a wax or wax-like nature, mentioned in lines 59-61 of page 1, and sound waves were directed so as to cause the style to vibrate in accordance with the sound waves, and if there were relative movement between the style and the tablet, the result of the combined action of the style and tablet would be elevations and depressions or other inequalities corresponding more or less perfectly to the form of sound waves, provided the vibrations of the cutting style were perpendicular to the surface of the tablet. 175

XQ23. And these elevations and depressions, being the creation or the result of the work done by the stylus, would constitute the record spoken of in the specification on the first page in line 16. Am I correct? 176

A. As I view it the record would consist of the solid substance having the elevations and depressions formed therein by the cutting style.

XQ24. The question is not how you may define in your own fashion the term "record," but whether it is correct, or is not correct, to say that the elevations and depressions that are the creation of, or the result of the work done by the stylus, constitute the "record" spoken of in the specification on the first page of line 16. Please answer this question categorically? 177

A. It is absolutely impossible to conceive of elevations and depressions as being separated from some substance in which or upon which such elevations and depressions are formed.

I would, therefore, say that any definition of the word record as employed in the paragraph in the specification from which you first quoted, which

178 ignored the tablet or substance, would be an incorrect definition of the word record.

XQ25. Supposing, now, a record such as you conceive of, and as the specification calls for is formed; and suppose you be asked to look at a part or portion of the solid substance where there are no elevations and depressions formed by the cutting style; and to state whether such portions as have not been operated upon by the cutting style, you would also call the record. What would you say?

179 A. I should state that a blank tablet was not a record, nor was a blank portion of a tablet a record, and that it was only such portions of the tablet as had acted in conjunction with the cutting style that could constitute such a record.

XQ26. Referring to Patent No. 341,214, there is found on page 1, lines 76 to 80, the following:

"The invention consists, thirdly, in cutting or engraving the record in the form of a groove with sloping walls, the sound waves being represented by elevations and depressions at the bottom of the groove, or otherwise."

Will you please state what your understanding of the meaning of the two words "or otherwise" is in this connection, bearing in mind that the record is produced by "cutting or engraving?"

180 A. I understand the two words "or otherwise" in the connection which they are used, to mean that in a groove having sloping walls the sound waves may be represented by elevations or depressions, or they might be represented other than by elevations and depressions; or again the sound-waves might be represented by elevations and depressions, the elevations and depressions being in the bottom of the groove or elsewhere than in the bottom of the groove. To make my meaning perfectly clear by giving an illustration, and bearing in mind that the term engraving as employed in this specification means the removal of the mate-

rial in chips or shavings or small pieces, the sound-groove formed in the tablet might be the zig-zag groove of the Cros French Patent, to which I referred in my direct-examination, in which case the sound-wave would be represented not by elevations and depressions at the bottom of the groove, but would be "otherwise" represented by the zig-zag side to side lines, that is the sinuosities of the line, in which case the sinuosities would be formed not on the bottom but on the side walls of the groove. 181

XQ27. Do you find in the specification of the patent in question any indication of an intention on the part of the patentees of comprising such latterly undulating record as you have just referred to by the words "or otherwise"? and in this connection you may point out from the specification any record there mentioned that is not represented by elevations and depressions at the bottom of the groove? 182

A. I do not find in the specification any specific mention of the laterally undulating or zig zag record, but I do find very clearly expressed the idea that the patentees did not intend to limit themselves to the specific form of record consisting in a tablet of solid substance having vertical undulations. In the clause beginning at line 76, page 1, the patentees clearly point out that the third feature of their invention consisted in cutting or engraving the record in the form of a groove with sloping walls without regard to whether the sound waves were represented by elevations and depressions "or otherwise." And as the laterally undulating or zig-zag record was at the time this specification was filed a well-known form of record, familiar to all those posted in the art, it is fair to presume that two such scientific gentlemen as Dr. Bell and Prof. Tainter were familiar with what was then well-known in the art and intended to include that which fairly falls 183

184 within the meaning of the words used by them. Again, on page 1, beginning at line 101 and ending in line 3 of page 2, they expressly mention the fact that they are aware of other forms of record than the one in the form of a groove with sloping walls. Furthermore, on page 6, lines 48 to 55 inclusive, the patentees state that

185 "In the foregoing description details have been given with some minuteness. This has been done to furnish the best information in our power for enabling those skilled in the art to make and use the invention, and not with the intention of limiting the invention to the precise dimensions, proportions, shapes and materials stated."

For the reasons given I am clearly of the opinion that while the patentees do not specifically mention the zig-zag or laterally undulating form of record, they nevertheless intended wherever the language was broad enough to include such record to so include it.

XQ28. You have not yet pointed out in the specification the mention of any specific record other than the one consisting of a groove in which the sound waves are represented by elevations and depressions at the bottom of the groove. Will you please do so?

186 A. Specifically I do not think that the patent describes any other form of record; nevertheless as I stated in my answer to XQ27, I do find very clearly expressed the idea that the patentees did not intend to limit themselves to the specific form of record with vertical undulations. And without repeating my reasons for this opinion I would simply say that they are the same as those given in my answer to XQ27.

XQ29. Do you mean to say that in the specification of the patent in question there is no mention of any other specific record than the one in which the sound waves are represented by elevations and depressions at the bottom of the groove?

A. I did not.

187

XQ30. Then please point out the other specific record referred to in the specification?

A. Page 1, line 37, the patent states, "it has been proposed to cut the record in the edge of a strip of metal or other solid material by vibrating the strip in contact with the cutting edge of a rotary disk cutter; but this proposal is essentially different from this invention, the new mode being applicable to cutting a record upon all sorts of surfaces and not upon strips only."

In the record thus cut on the edge of a strip the sound waves would not be represented by elevations and depressions at the bottom of the groove.

188

XQ31. How else would the sound waves be represented on the edge of such a strip?

A. The sound waves on such a strip would be represented by the irregularities on the edge of the strip. Assuming such strip to be placed in a vertical position the irregularities might be referred to as elevations and depressions, but if the strip were laid flat the irregularities representing the sound waves would constitute what we have previously referred to as a latterly undulating or zig-zag record. The vertical record being in this case readily transformed into a latterly undulating record. I need not add that the edge of the strip does not constitute a groove.

189

XQ32. If this strip be placed on edge then the sound waves would be represented by a vertically undulating ridge. Is this correct?

A. I should not refer to the edge of the strip as a ridge. The sound waves would be represented by the irregularities on the edge of the strip.

XQ33. Is this all that you find in the patent now in review, as regards specifically described records other than records in which the sound waves are represented by elevations and depressions in the bottom of the groove?

190 A. The only other specifically mentioned record which I at this moment recall is that of the Edison indented tin-foil record, in which the sound waves are represented by elevations and depressions in the bottom of the groove.

XQ34. Can you point to any other patent or public record of Messrs. Bell and Tainter or either of them in which any other specific record of sound waves is referred to or described?

191 A. On the 20th of October, 1881, Alexander Graham Bell, Sumner Tainter and Chichester A. Bell, the latter two being the patentees of Patent No. 341,214, herein in suit, deposited in the Smithsonian Institution in this city, a sealed package containing among other things a description of their experiments and the resulting method of recording and reproducing sound.

They state:

192 "Our invention consists, in the first place, of a new form of phonograph, or apparatus for recording sounds by the voice; and in the second place, of a new kind of graphophone or apparatus for reproducing sound from a phonogram or permanent record. The phonograph consists of a flexible diaphragm, which can be thrown into vibration by the voice, and which communicates its vibrations to an engraving tool resting upon the film or coating of wax, paraffine or other similar substance, on or into which the voice record is to be engraved. The end of the cutting tool presses against the prepared substance, and cuts out a groove of considerable width, as the prepared substance is moved past the end of the tool. Under these circumstances, when a person speaks against the diaphragm of the phonograph, its vibrations are communicated to the tool, so as to cause a to and fro motion of the end in contact with the prepared substance. This motion may be either in a plane parallel to the surface of the prepared substances, so as to produce a wavy or zig zag line of uniform depth, or it may be in a plane

perpendicular to the surface, so as to cut out a straight groove of varying depth, as may be desired. A phonogram of either of these kinds may be copied in more durable material by any of the well known moulding or electroplating processes; and the sound may be reproduced either from the original phonogram or from one of the copies." 193

I think this very clearly demonstrates that Messrs. Bell and Tainter were acquainted with the record in the form of a wavy or zig-zag line of uniform depth, and that when they referred to other forms of record they meant to include in this general statement said wavy or zig-zag form.

XQ35. You did not, I suppose, recite what you have above quoted from memory? Will you please, therefore state from what paper you took the quoted passage, and particularly whether it was the sealed package to which you referred from which you took the matter you quoted? 194

A. I quoted from a printed copy of the record in the case of the American Graphophone Company vs. The United States Phonograph Company, *et al.*, in the Circuit Court of the United States for the District of New Jersey, in which record a copy of the sealed package referred to as being deposited in the Smithsonian Institution appears as an exhibit. The suit above referred to was for an alleged infringement of patents Nos. 341,214 and 341,288 here in suit. 195

XQ36. What is the date of the particular portion of the court record from which you have taken the passage supposed to be found in a sealed record deposited in the Smithsonian Institution?

A. The bill of complaint in the case referred to was filed October 15th, 1894. Testimony was taken during the years 1895, 1896, etc. The dates given I presume will furnish the date desired by your question.

XQ37. Do you know of your own knowledge that the sealed package in question was actually

196 deposited in the Smithsonian Institution, and if so, that it actually contained the matter which you quoted therefrom in your answer to XQ34?

A. I do not.

XQ38. This being the case, how is it that you speak of that alleged paper as proving to your mind that Messrs. Bell and Tainter when writing their patent specification here in review, meant to include a laterally undulating record by the words "or otherwise?"

107 A. That Bell and Tainter did deposit such a paper is known to me as a part of the well authenticated history of the art of recording and reproducing sound, just as is the other similar fact that Cros, in 1877, deposited a statement with the French Academy, setting forth his proposed method for making an undulatory or zig-zag record. I never saw the paper deposited by Cros. That he did deposit such a paper is however a part of the well authenticated history of the art, and known to me as such.

108 XQ39. Now Mr. Cameron you are an attorney-at-law, and you know quite well that you have no proof that Cros ever deposited a sealed paper in the French Academy; that all you know is that at a later date a publication appeared that said so. Similarly you do not know that Bell and Tainter deposited anything in the Smithsonian Institution excepting so far as something of the sort has been alleged in the suit to which you refer long after the patent No. 341,214 here in review was issued. Under these circumstances is it not a fact that what you said about Bell and Tainter's sealed package comes to you as mere hearsay?

A. As a part of my duty as an expert in this art I have sought to post myself as far as possible in regard to the literature of the art, as well as the patented and practical side of the art. I have the authority of Mr. Emile Berliner for the statement that "on the 30th day of April, 1877, Mr.

Charles Cros deposited with the Secretary of the Academy of Sciences a sealed envelope, containing what in translation reads as follows: 199

Here follows a quotation by Mr. Berliner of what purports to be a translation of the paper deposited by Mr. Cros. I accept such published statement as a part of the literature of the art of recording and reproducing sound and as such have referred to it in my examination in chief and I think properly so. The knowledge of the paper deposited by Messrs. Bell and Tainter in the Smithsonian Institution, came to me in the same way, that is as a part of the literature of the art and I referred to it in precisely the same way 200 that I referred to the Cros paper.

I have no hesitation, however, in stating again that neither the Cros paper nor the Bell and Tainter paper is a matter of personal knowledge with myself.

XQ40. It appears then that you are willing to extend your knowledge of the art backwardly by all sorts of printed statements, and that you are willing to interpret the meaning and import of language found in the patent by the aid of such printed statements. The same as if you yourself had knowledge of the facts which you find in such printed statements?

A. I am willing to add to my knowledge of the art by information gleaned from any well authenticated source and I would not hesitate to interpret this or any other patent from the standpoint of what was well known in the art at the time the patent application was made. 201

XQ41. Did you ever see such laterally undulating record of sound waves as is referred to in the so-called sealed package; that is to say have you ever seen a sound record produced by a cutting style in the manner described in that sealed package?

A. I think not.

202 XQ42. Have you any reason to believe that such a sound record can be made for the reproduction of sounds therefrom?

A. I have very little doubt that such record could be made.

XQ43. Please give whatever little doubt you have?

A. The only doubt that I have is one which a man with some experience in this art would naturally entertain in regard to an operation which he had not actually performed.

203 XQ44. In interpreting, however, the meaning of the words "or otherwise" in the paragraph on page 1, lines 75 to 83 in Patent No. 341,214, you did not doubt for a single moment and spoke quite assuredly of the laterally undulating record as a part of the pre-existing state of the art, while now you entertain some little doubt as to the possibility of making such a record in the fashion described in the so-called sealed package. How is it that your attitude has undergone some change?

204 A. My attitude has undergone no change whatever. The state of the art at the date of the Bell and Tainter patent is not represented solely by the statements contained in the sealed package deposited by these gentlemen in the Smithsonian Institution, but is also represented by the French patent to Cros of 1878, No. 124,213. In that patent Cros specifically mentions the transversely undulated form of record, and, as I have previously stated, I cannot doubt that gentlemen well posted in the art of recording and reproducing sound, as Messrs. Bell and Tainter were, were familiar with all that this patent contains. So that when I stated that I regarded the broader expressions of the Patent No. 341,214 as intended to include the transversely undulating or zig-zag form of record I was not by any means depending entirely upon matter contained in the package deposited by Messrs. Bell and Tainter in the Smithsonian In-

stitution. Such package, however, contains very strong corroborative proof that I was not mistaken in the construction which I placed upon the expression in the Patent No. 341,214 in suit. 205

XQ45. Do you know whether the French patentee Cros has ever made a record of sound waves such as is described in his patent?

A. I do not.

XQ46. Did you ever see a sound-record made in accordance with the specification of the French patent to Cros?

A. I never did.

XQ47. Supposing now there be a sound-record such as is described in the patent No. 341,214 in suit, and it be said of such record that the reproducing style is pressed against the record by the yielding pressure of a spring or weight. Where would the point of the style be arrested? 206

A. That would depend upon the shape of the so-called point of the style and upon the size thereof. In the style now most generally used in connection with records cut in a wax-like surface, the rubbing point of the style is spherical or semi-spherical, and is not, strictly speaking, a geometrical point. Such a style makes contact with the surface of the record beginning at the top of the sloping wall of the groove on one side and continuing such contact down the sloping sides of the wall along the bottom of the sound groove and up the sloping side of the other wall. In a sound groove with sloping walls of the character commonly employed in the gramophone, an example of which is found in Complainant's Exhibit, Defendants' Sound Record, the point of the style enters the sound groove and forms complete contact with the sides and the bottom thereof in the same way that the rubbing style does in the record in wax. I may add that I have repeatedly demonstrated this to be true by microphotographs taken of the point of the style employed in Complainant's Exhibit, Defendants' Machine. 207

208 Answer objected to by counsel for defendants as irresponsible and inexcusably volunteered.

XQ48. Now, Mr. Cameron, please divest yourself for the moment of the impression that you are testifying in behalf of the complainant in this case, and do not argue the case as a whole in response to specific questions. With this understanding please state how and where the reproducing style shown and described in Patent No. 341,214 will be arrested when in the language of the patent it is "pressed against the record by the yielding pressure of a spring or weight;" and please consider in
209 your answer no other record and no other machine, whether complainant's or defendants', than the one that is shown and described in the patent here in review?

A. Without undertaking to reply to the wholly uncalled for and unjustifiable lecture delivered by counsel for the defendant, further than to call attention to the fact that counsel has now presented a specific question, specifically limited to a certain well defined structure, I would answer the question by saying that in the machine described in the patent in suit, the point of the style would be arrested in the sound groove. That whether it
210 would be on the extreme bottom, or whether it would be on the bottom at all, or whether it would be on the side walls of the groove, would depend entirely upon the particular outline of the recording style and the reproducing style, as well as the size of the groove and the size of the reproducing style. In the absence of specifications in regard to these details I would not undertake to state the exact point in the groove at which the reproducing style would be arrested.

Adjourned by agreement to Thursday,
June 1st, 1899, at 10.30.

Washington, D. C., 211
June 1st, 1899.

Met pursuant to adjournment.

Present: Parties as before.

Mr. Lynde continues cross-examination of Mr. Cameron.

XQ49. In answer to XQ48 you have stated your inability of assigning any particular spot or exact point in the record groove at which the reproducing style would be arrested when it is "pressed against the record by the yielding pressure of a spring or weight." I now call your attention to the specification of patent No. 341,214, where on page 4, lines 62 to 67, the operative relation between the reproducer and the record is spoken in these words: 212

"No special care is necessary to insure its adjustment, for if the reproducer K be allowed to rest against the record with the style upon the engraved line, the style will of itself gravitate to the bottom of the groove."

Does it not appear from this that the patentees understood that the style when pressed against the record by the yielding pressure of a spring or weight would finally be arrested by contact with the bottom of the groove?

A. In the particular form of record which is described as constituting a portion of the invention described in patent No. 341,214, A suitably formed reproducer would, when placed upon the record, undoubtedly contact with the bottom of the sound groove, and as one form of record is described as a sound groove having sloping walls if the reproducer when originally placed upon the record was arrested by contact with such sloping walls, it would inevitably "gravitate to the bottom of the groove" as stated in the portion of the specification from which you have quoted. 213

XQ50. In your last answer you seem to intimate that more than one form of sound-groove is de

214 scribed in the specification; yet in the former part of your testimony when you were asked to point out any other form of sound record described in the specification, you were unable to do so. Are we here to understand that you have since discovered another form of sound record described in the specification?

A. In the series of cross-questions extending from XQ27 to and through XQ30, I was asked to point out in the specification any mention of any specific record other than one consisting of a groove in which the sound waves were represented by elevations and depressions at the bottom of the groove, without any mention being made as to
215 whether the sound-groove, was one with or without sloping walls.

In my answer to XQ49 I referred to a sound-groove with sloping walls, which is the specific form of groove mentioned in lines 76 to 80 of page 1 of the specification.

It is quite feasible however to cut or engrave a sound groove having elevations or depressions in the bottom of the groove corresponding to sound waves, the side walls of the groove being vertical; so that when in my answer to XQ49 I mentioned a groove with sloping walls I only indicated one specific form of the sound groove to which your
216 previous cross questions 28 to 30 referred.

XQ51. Please state now, so that there may be no mistake about it, whether the specification describes any other sound-groove than one having sloping walls. And in answering this question please confine yourself to what you find in the specification and do not revert to matters which you deem practical or possible?

A. The specification states, on page 1, lines 15 to 19, that

"The invention consists, first, in the formation of the record or phonogram, as it has been called, by means of a cutting style which

is vibrated by the sound-waves or sonorous vibrations to be recorded." 217

The specification states, in lines 48 to 55 of page 6 that it is not the intention to limit the invention to the precise shapes stated. Claims 7 and 8, for example, specify a sound-record consisting of a tablet having its surface cut or engraved with narrow lines of irregular or varied form corresponding to sound waves. The only specific form of sound groove described is the one mentioned in lines 76 to 80 of page 1, which lines I have quoted in my previous answer, but it is very clear from the statements in the specification to which I have just referred, and from the claims thereof, that such specific form of groove, viz, one having sloping walls, is mentioned merely as one means of expressing the inventive idea set forth in the patent and not with the idea or intent of limiting the patentees to such specific construction. 218

XQ52. I take it that your last answer, if divested of the portions that are not responsive to the question is that there is not found in the specification a description of any other sound groove than one having sloping walls. Did I correctly understand your answer?

A. Broadly the specification defines a cut or engraved sound-groove having elevations and depressions corresponding to the sound waves, and mentions as a form of said sound-groove one having sloping walls. I stated in my last answer, and I think plain enough so that there can be no doubt about it, that specifically the specification describes only a sound-groove with sloping walls. 219

XQ53. Now in such sound-groove, the style being "pressed against the record by the yielding pressure of a spring or weight" will be ultimately arrested at the bottom of the groove, as you have stated in your answer to XQ49. This being the case it would seem that the patentees having said as much as this in their own words, which you

220 have quoted, evidently meant to give to their sound-groove and to their reproducing style such dimensions as would make it possible for the style to get down to the bottom of the groove. Does it not seem from this that when in answer to XQ48 you have said that you were unable to state the exact point in the groove where the style would be arrested because the specification failed to give dimensions, etc., you created a difficulty that the patentees did not experience. In other words, is it not quite clear from the specification, that the patentees meant to have the reproducing style carried down to the bottom of the groove by the elastic pressure of a spring or weight?

221 A. As I have repeatedly stated, the specification clearly sets out broadly the idea of a record consisting of a sound-groove without undertaking to limit the invention to any specific form of sound-groove. It does, however, specifically describe one form of groove in which the inventive idea is embodied. In such a sound-groove, viz., one with sloping walls, the style, would, as I have stated, if arrested upon the sloping wall of the groove tend to gravitate toward the bottom thereof. Your question persistently ignores the fact however that the groove with sloping walls is but a specific embodiment of the broad idea which consists of a
222 groove of any form provided it is cut or engraved in the surface of the tablet. My reply to XQ48 was directed to the broad idea of an engraved sound-groove and with such understanding my statement therein was not one creating any difficulties whatever but simply pointing out that in the absence of a more specific statement than what was contained in your question, it could not be accurately stated where the point of the stylus would be arrested in the groove.

XQ54. You were, however, in XQ48, requested to consider no other record, no other style, and no other machine than the one shown and

described in the patent in question. Now, in such machine, with such a style and with such a groove as are specifically described in the patent, I understand you now to state that the style will be carried down to the bottom of the groove by the elastic pressure of a spring or weight. Do I now clearly understand you? 223

A. In the specific form of groove with sloping walls described, such would be the action of the style.

XQ55. Now you have conceived of the possibility of cutting a sound-groove having elevations and depressions at the bottom, but vertical walls. Will you now please state whether in such construction the stylus would not also be carried down to the bottom of the groove? 224

A. It would.

XQ56. Is there any intimation found in the specification of this patent No. 341,214, of a construction of a sound-groove and stylus where the reproducing style will not be carried down to the bottom of the groove?

A. I think there is, yes, sir. Commencing at line 101, page 1, the specification states:

"The reproducing style, mounted as just explained, is specially adapted for use in connection with a record in the form of a groove with sloping walls, and this combination is specially claimed; but it may also be usefully employed in connection with other forms of record." 225

This sentence clearly indicates that the reproducer mounted so as to have the style pressed against the record by the yielding pressure of a spring or weight, is designed to be used with other forms of record than the one specifically described in the specification.

XQ57. The passage which you have quoted says, does it not, that the reproducing style mounted as explained may be usefully employed

226 with other forms of record than such as are formed by a groove with sloping walls. Does it say more than that?

A. The passage quoted speaks for itself.

227 XQ58. But you have used this passage by way of argument in support of your contention that there is an intimation in the specification of a construction of sound-groove and stylus wherein the style would not be carried down to the bottom of the groove. This being the case it would seem only fair to get at your understanding of the meaning of the passage. Please therefore state whether the passage you have quoted says more than that the reproducer mounted so as to have the style rest against the record by the yielding pressure of a spring or weight may be usefully employed with other forms of record than such as are formed by a groove with sloping walls?

228 A. The passage goes no further than you have stated in your question, that is, that the reproducer mounted as described may be usefully employed with other forms of sound-grooves than those having sloping walls. With a sound-groove having sloping walls the point of the stylus would be carried down the sloping walls to the bottom of the groove, whereas in other forms of record, that is, forms which do not have sloping walls, while the point of the stylus might or might not ultimately rest on the bottom of the groove, it would not be carried to the bottom if it did rest there, by the walls of the groove.

XQ59. It would be carried to the bottom of the groove, however, by the pressure of a spring or a weight?

A. Assuming that the point of the style was small enough to enter the groove, I should say that the point of the style would rest on the bottom of the groove, if it had one.

XQ60. So that after all you have not yet pointed out in the specification any intimation that would

convey the idea that the patentees had in mind 229
any other construction of groove and style than
such as would make the style come to the bottom
of the groove by the action of a spring or weight.
Are you now willing to say that all throughout
the specification of the patent in review, there is
found neither a word nor a sentence that would
convey the idea of any other construction than
such whereby the reproducing style is carried
down to the bottom of the sound groove by the
yielding pressure of a spring or weight?

A. I do not find anything in the specification
which states that when the reproducing style is
resting in the sound groove under the yielding 230
pressure of a spring or weight, that the style
would not make contact with the bottom of the
groove.

XQ61. Now resting at the bottom of the groove
the style is in operative contact with the elevations
and depressions which represent the sound waves.
Is this correct?

A. I think that is correct.

XQ62. And when these elevations and depres-
sions at the bottom of the groove are moved along
lineally as by the rotation of the disk in which
they are formed, the stylus will receive movements
corresponding with such elevations and depres-
sions; will in its turn impart such movements to 231
the reproducing diaphragm and the latter impart-
ing its movements to the air will thus give rise to
sounds similar in character to those by which the
elevations and depressions in the bottom of the
groove have been formed. Is this a correct state-
ment?

A. It is.

XQ63. In the specification of patent No. 341,-
214, on page 4, lines 68 to 70, it is pointed out
that there might be difficulties in making the
stylus touch the record "precisely at the proper
point if the reproducer be held rigidly" and the

232 specification then says "difficulties on these accounts are avoided by the loose or flexible mounting of the reproducer, the style automatically adjusting itself to the proper place on the record." Will you please state what you understand to be the "proper place on the record?"

A. The proper place on the record would be that part of the record having the irregularities corresponding to sound waves formed therein.

XQ64. Consequently the proper place would be the bottom of the groove where there are the elevations and depressions that represent the sound waves. Am I right?

233 A. If the sound groove were one whose irregularities corresponding to sound waves consist in elevations and depressions at the bottom of the groove, then you would be right; but if the sound groove were one in which the irregularities corresponding to sound waves were formed in the sides rather than in the bottom of the groove, as in the case of the Cros zig-zag record, then you are wrong. The specification requires or rather provides a construction which shall insure that the reproducing style shall touch the record precisely at the proper or most advantageous point. In either form of record that is, the vertically undulating or laterally undulating, the proper point for the reproducing style to touch is along the line of irregularities corresponding to sound waves.

234

XQ65. Let us confine ourselves temporarily to the sound record so described in the specification that there can be no doubt about it; namely, to the record formed by a groove with sloping walls having elevations and depressions in the bottom of the groove, these elevations and depressions representing the sound-waves. We shall speak of the Cros record by and by.

Now with such record as the specification clearly describes where the stylus, as you have said, if it should primarily come in contact with the sloping

wall would slide down that wall, impelled by a spring or a weight, until it reaches the bottom of the groove which is the "proper place" for it to reach; it is necessary, is it not, that the point of the style be small enough to allow it to have that sidewise motion from the sloping wall to the bottom of the groove. In other words, the point of the style must be narrower than the groove. Am I correct? 235

A. In actual practice when sound grooves are cut or engraved in a solid substance in accordance with the specification of patent No. 341,214 in suit, the groove varies greatly in width and is in cross section approximately in the form of an arc. The reproducing style which co-acts with this groove is not a geometrical point, but is hemispherical in shape. When this style is brought into position in the groove the shape of the groove and the style is such that the style readily comes in contact with the irregularities in the groove corresponding to sound waves, but I should hesitate to state that the rubbing point of the stylus was or had to be at all times smaller or narrower than the groove itself. That is I do not understand that the point of the stylus *must* be so small that it may rattle around, so to speak, in the groove but that it *may* be so is, I think, true. 236

XQ66. There is no question about the point of the stylus rattling around in the groove; nor is there any question of the construction of apparatus in actual use. We have here to deal with the construction shown and described in the patent. Now, with such construction with which the style automatically adjusts itself to the proper place on the record by sliding down the sloping wall, is it not the fact that the point of the stylus must be narrower than the width of the groove? 237

A. The construction of groove to which I referred in the first part of my last answer is in exact accordance with the groove specifically defined in

238 the patent, that is a groove with sloping walls. The reproducing stylus has a rubbing point which makes contact with the irregularities constituting the sound groove, so that I think in my last answer I confined myself to the construction mentioned by you in the question to which it was responsive, and I therefore repeat, for the reasons given in my last answer, that I should hesitate to state that the rubbing point of the stylus was or had to be at all times smaller or narrower than the groove itself.

Answer objected to as not responsive.

239 XQ67. Please look at the Patent No. 341,214; inspect the drawings thereof and read as much of the specification as you may deem necessary to get at the construction of both the recording style and reproducing style. You will thereby obtain a mental image of the sound groove produced by that machine and you will then be able to say, without reference to anything that you may find in actual use, whether the reproducing style is not, as a matter of fact, narrower than the sound groove; and whether it must not be narrower in order that it may slide down the sloping wall to adjust itself automatically to the proper place on the record; that is to say at the bottom of the groove?

240 A. The point of the reproducing style need not necessarily be narrower than the sound groove in order that the point of the style make contact with the elevations and depressions in the bottom of the groove. A reproducing style point whose outline is exactly commensurate with a cross-section of the sound groove could and would, if placed upon one of the side walls of the groove slide down into and exactly fill the groove, making contact with the irregularities in the bottom thereof precisely as defined in the patent.

XQ68. Will you please point to that portion of the drawing of the patent which best represents the shape of the recording style?

A. Figures 5 and 6 show the recording style 241
per se separated from the other portions of the instrument.

XQ69. Will you now please point out that part of the drawings of the patent which best represent the reproducing style?

A. Figures 7 to 10 inclusive.

XQ70. Now comparing Figs. 5 and 6 on the one hand, with Figs. 7 to 10 inclusive on the other hand, is it not clear that the reproducing style as a whole and its point in particular is very much narrower than the cutting style as a whole and its point in particular?

A. The figures representing the recording style 242
or engraver show the same as larger than figures 7 to 10 inclusive show the reproducing style; but I find on page 3, lines 2 and 3 the statement that Figures 5 and 6 are views on a large scale of the graver or cutting style, and in the next two lines I find the statement that Figures 7 and 8 are views in elevation and section respectively of the reproducer without any statement to the effect that the same are on an enlarged scale. I do not therefore feel that a comparison of the mere outlines of Figures 5 and 6 showing the recorder, and Figures 7 to 10 showing the reproducer affords any means of arriving at the comparative sizes of the recording and reproducing styles because the two styles 243
are shown in figures drawn to different scales.

XQ71. It is then your opinion that if the reproducing style were exactly of the size of the sound groove, it could still slide down the sloping walls to the bottom of the groove. Will you now state whether it could do so if it were wider than the sound groove?

A. If the point of the style is to enter the groove it is I think apparent that it could not do so if it were wider than the groove, and make contact with the bottom thereof.

XQ72. Now you have stated, although you

244 were not called upon to do so, that in actual practice the sound groove is of varying width. This being the case, and since the reproducing style is only a single structure of definite dimensions, does it not follow that it must be made narrower than the average width of the sound-groove, since otherwise it could not gravitate to the bottom of the groove where it is at the narrowest?

A. It does not, as I stated before in actual practice the cross-sectional outline of the sound-groove is approximately that of the arc of a circle, the irregularities corresponding to sound-waves
215 would be found throughout the extent of this arc. The rubbing point of the reproducing stylus is struck on approximately the same radius as the arc constituting the cross section of the sound-groove. With such a groove it would be very difficult to state where the line of demarcation between the walls and the bottom of the groove would occur, bearing in mind that the groove may be as wide as the one one-hundredth of an inch and not more than the one one-thousandth of an inch in depth. The assumption in your question, therefore, to the effect that the bottom of the groove is the narrowest part thereof does not hold strictly true since the entire arc upon which the groove is
246 struck may be regarded as the bottom of the groove. With a recording stylus struck on the same arc as the cross-section of the groove, it is apparent (whether the groove was the one one-hundredth or the one five-hundredth of an inch in width), the rubbing point of the stylus would make equal contact with the irregularities representing the sound-waves in said groove.

XQ73. Will you please state where, in a groove of this description, the sloping walls are found, seeing that you find that your groove is all bottom?

A. The walls begin at one side of the groove,

slope downward to the middle point of the groove, and slope upward from that point to the opposite edge of the groove, very much as would be the case if you had a V-shaped groove in which case the slope of the walls would be from one edge to the medial line and up again to the opposite edge, the difference in the two cases being that in the one the slope is on a circular line whereas in the other it is on a straight line. 247

XQ74. Your groove has now, as you describe it, no bottom, but only sloping walls terminating in a common mathematical line; while with a V-shaped groove there are both sloping walls and a distinct bottom since, as you would perhaps admit, there is no such thing as a cutting style with a mathematical point. In other words, a V-shaped cutting style with which material is to be cut or engraved must have an appreciable though small width of point. Have I correctly stated the distinguishing characteristics between an arc shaped groove that has either all bottom or all walls, and the V-shaped groove that has both bottom and walls? 248

A. A groove approximately arc shaped in cross-section certainly has both bottom and side walls and no amount of ingenious hair-splitting can change this fact. That a V-shaped groove would not in actual practice have its side walls meet in a geometrical medial line, is I think correct, as such groove would almost inevitably have its side walls connected at the bottom with a slightly curved portion, such as I have described the groove in Complainant's Exhibit Defendants' Record to be. I think you are correct in your statement that a cutting style must have a point with some appreciable though small width. 249

XQ75. Will you now turn again to Patent No. 341,214. Do you not find the cutting style approximately V-shaped?

250 A. I find the cutting style to have a point such as would be obtained by taking a cylinder and slicing or cutting away a portion thereof on a somewhat diagonal line. This might perhaps be styled approximately V-shaped, but clearly it does not give a point having the two sides thereof approaching to a central line or point so as to make a clean cut sharp angle at their point of union. The point is in fact slightly rounded, as is most clearly shown in the enlarged view of Fig. 6. It must be borne in mind, however, that the cutting portion of this style, being only about the one one-thousandth of an inch from the end thereof, is
251 so small that the width of the groove to be cut thereby, in proportion to the depth, is very great and would even with the somewhat crude outline shown in Fig. 6, give a groove which would be approximately arc-shaped in cross-section.

XQ76. Will you point to that part of the specification that tells you that the depth of the groove will be only about one one thousandths of an inch?

A. I did not gain my information in regard to the depth of the groove from the specification, but from a study of the groove as actually made in practice. So far as I am aware there is no statement in the specification to the effect that the groove will be only one one-thousandth of an inch
252 in depth. Furthermore I do not wish to be understood as fixing this as the absolute and invariable depth of the cut or engraved sound groove, as the depth of such groove varies somewhat on both sides of this line.

XQ77. Have you ever seen a machine constructed exactly like those represented in the drawings of patent No. 341,214?

A. I have not.

XQ78. Have you ever seen a sound-record produced by such a machine?

A. I have not.

XQ79. The cutting and reproducing styles of machines with which you are familiar are shaped differently from those here shown and described in the patent? 253

A. The recording style of machines with which I am familiar has the engraving point made substantially as is described in the patent; that is by taking a cylinder, turning the end conical, rounding the extremity and grinding off one side to the axis, though in many and perhaps the majority of instances the cylinder is ground off clear across but on a diagonal line to the longitudinal center thereof. The reproducing style now in use differs somewhat from that specifically shown in the patent, in that the rubbing point is rounded or hemispherical. In regard to the recorder I note that the patent states, in lines 73 and 74 of page 3 that it is not essential to give to the recording style the particular form described in the specification, as any form which will remove the material and not simply displace it would answer. 254

The last sentence of the answer is objected to as irresponsible and volunteered.

XQ80. In those majority cases where the cutting style is made by grinding the cylinder off right across its axis, the end of the cylinder is not first rounded off, I suppose? 255

A. The grind across the cylinder is on a line diagonal to its longitudinal axis, not right across the same; and the result is practically the same point or cutting edge as was obtained by first forming a cylindrical piece of material, turning the point conical, rounding said point or extremity and then grinding off one side to the axis, the same results being obtained in a much simpler way by a single grind diagonally across the cylinder.

XQ81. It seems, after all, that the cutting style of the patent, as well as the reproducing style of the same, is different from those with the use of

256 which you are familiar; and since the machines as a whole are different, it will be of advantage to disregard in what follows your practical experience and to confine ourselves to your knowledge of the patent. Now, bearing in mind that the patent does not tell you how deep the record groove is, and also bearing in mind that the record groove has a varying width, as you have stated, are you not willing to say that the width of the reproducing style must be narrower than the average width of the sound groove, since otherwise the style could not gravitate down the side walls to the bottom of the groove, in all cases?

257 A. The cutting style with which I am familiar is practically the same shape as that described in the patent, though a somewhat different method is followed in making the same from that described in the patent. As I have repeatedly stated heretofore, the sound groove being in cross section approximately that of the arc of a circle, I have no hesitation in stating that it is not necessary that the width of the reproducing style must be less than the average width of the sound-groove. And I must dissent from the closing remark in your question to the effect that unless such were the case the "style could not gravitate down the side walls to the bottom of the groove, in all cases."

258 It must be borne in mind that in the art of recording and reproducing sound, we are dealing with extremely minute proportions, that even in the reproducing style shown in the patent the point of the style back for an infinitesimal distance, such as one or two-thousandths of an inch, is not in fact a geometrical point, and if placed under a high power glass it will be shown to be many times wider than any possible depth of a groove which could be cut by the working force of anything as weak as sound-waves. Said point would be found, when thus magnified and examined, to be a rounded rather than a geometrical

point, so that it would approximately fit and fill the curved or arc-shaped groove cut by a recording stylus of the shape described in the specification. I need not add that in a shallow groove there would be less of this point within the groove than would be the case in a deeper groove, but practically the reproducing stylus would make contact with the entire contour of the groove, though such contact is not essential in the operation of the style in reproducing sound. 259

Adjourned to Friday, June 2d, at 10:30 a. m.

Washington, D. C., Friday June 2d, 1899. 260

Present: Parties as before.

Mr. Lyons continues cross-examination of Mr. Cameron:

XQ82. Please give a brief description of the co-operative relation of the record tablet and the reproducer in the machines shown and described in patent No. 341,214?

A. The reproducer as a whole consists of a vibratory diaphragm supported in a suitable head or casing and having a rubbing point or style attached thereto. The record tablet has its surface cut or engraved with narrow lines of irregular or varied form corresponding to sound-waves. As shown in Fig. 1 of the drawings this tablet is in the form of a disk. In the act of reproducing sounds the style or rubbing point of the reproducer rests against the irregular lines in the tablet constituting the sound groove, these lines being arranged as a spiral upon the face of the tablet. The tablet is revolved and at the same time given translatory motion in a right line past the point of the style. The result is that the irregularities corresponding to sound waves are rapidly passed under the point of the style which is therefore given movements corresponding to said irregularities. These movements or vibrations of the 261

262 style are transmitted to the diaphragm of the reproducer which in turn sets up vibrations in the air similar to the original sound waves.

XQ83. Will you please state whether the term "irregular lines" or "lines of irregular form" occurs in the specification?

A. It does. Claim 7 defines the tablet as having "its surface cut or engraved with narrow lines of irregular or varied form corresponding to sound waves."

XQ84. But all throughout the specification the irregularities are understood to be the elevations and depressions at the bottom of the groove. Is this so?

263 A. I certainly do not so understand it. I simply understand that a sound-groove having elevations and depressions at the bottom of the groove is given as an example of a cut or engraved line of irregular form corresponding to sound-waves, but I do not understand that the specification is by any means limited to this specific form of irregular line.

XQ85. Is any other example given?

A. This is the only one given.

264 XQ86. It will therefore be safe, henceforth, in this examination when speaking of the sound record described in the patent No. 341,214, to understand that it is formed by elevations and depressions in the bottom of the groove. This will obviate the necessity of asking the same question over and over again.

Now, as regards the machine as a whole, which you have very briefly described in your answer to XQ82, you said that the tablet is revolved and is at the same time given a translatory motion in a right line. You have not said anything about the motions, if any, that are given to the reproducing style, except those vibratory motions which are imparted to it by the elevations and depressions in the sound groove. Is there any other motion given to the stylus?

A. In all record tablets there are two classes of irregularities, first, irregularities corresponding to sound waves; these are the irregularities which give the reproducing style its vibratory movements mentioned in my answer to XQS2; second, there are irregularities in the tablet due to imperfections of construction, such as unevenness of the surface of the tablet, warping when it is a disk, eccentricities when the tablet is a cylinder, etc. The reproducer shown described and claimed in patent No. 341,214, in suit, is mounted on a universal joint so that it may have free movement in every direction. This second class of irregularities in the tablet, which I have mentioned, causes the reproducing body as a whole, including the head, diaphragm and style, to move in accordance with such irregularities, but without in any way affecting the vibrations of the style and diaphragm imparted thereto by the irregularities corresponding to sound waves. The style therefore has in addition to its vibratory movements, a movement imparted to it by the irregularities of the surface of the tablet, that is by the unevenness, warping or eccentricities of the tablet. In addition to this the style has a third movement parallel with the face of the tablet which permits it to follow and adjust itself to the record groove. The patent states on page 4, lines 79 to 84:

"It will be seen that the reproducer is mounted on a universal joint, so that it can move in any direction. The movement parallel with the face of the tablet would, however, by itself allow the style to follow and adjust itself to the record to a useful extent."

Thus if there should be any disarrangement in the machine by which the record disk was not given its translatory movement past the point of the style, this style would nevertheless remain in the spiral sound groove and follow the record,

268 moving across the face of the tablet in a line parallel therewith.

It will be seen therefore, that in the act of reproducing, the reproducing style has three movements, First, the vibratory movement imparted to it by the irregularities corresponding to sound waves.

Second, the movement due to unevenness or other irregularities in the surface of the tablet, and

Third, the movement across or parallel with the face of the tablet which enables it to follow the record.

269 XQ87. As regards this last kind of movement I understand from your answer that it will be brought about whenever there should be such disarrangement of the machine by which the record disk was not given its translatory movement. Will you now please state whether or no this idea has flashed through your mind for the first time at this moment, whether you find any warrant for this in the specification of the patent; and whether you are not now speaking of this point with a view to what occurs in defendant's machine and not with what occurs in a machine constructed in accordance with the patent here in review?

270 A. Answering the first part of your question I will say that the idea has not for the first time flashed across my mind in connection with my last answer. In my direct-examination, in answer to Question 5 and on page 12 of the type-written copy of my deposition, I stated,

"The object of thus loosely mounting the reproducer is not only to enable it to adjust itself to the irregularities of construction, which I have just mentioned, but is also for the purpose of enabling the reproducer to be guided and moved by the record."

And I thereupon quoted from the specification of the patent in suit, on page 4, lines 68 to 84. in

which specific mention is made of the liability of 271
disarrangement in some part of the machine.
Furthermore, the passage quoted states that these
difficulties are avoided by the loose mounting of
the reproducer and then follows the statement,
which I quoted in my last answer, to the effect
that the movement of the reproducing style
parallel with the face of the tablet would allow
the style to follow the record.

Answering the second part of your question, I
find the warrant for my statement that the style
has a third movement across or parallel with the
face of the tablet which enables it to follow the
record, in that portion of the specification, lines 79 272
to 84, page 4, which I quoted in my answer to
XQ86.

Answering the third section of your question, I
was speaking in answer to your XQ86 which asked
me if there was any other motion given to the re-
producing stylus in patent No. 341,214, other than
the vibratory movement imparted to it by the
irregularities of the sound groove. The specifica-
tion of patent No. 341,214 clearly describes this
third movement parallel with the face of the
record. My answer was clearly responsive to the
question asked by yourself and while I am well
aware that this movement of the reproducing stylus
parallel to the face of the record tablet is the 273
same as that employed by defendants in their
machines, as shown by Complainant's Exhibit De-
fendant's Machine, I do not conceive that that fact
places upon me any duty to wholly ignore a move-
ment of the reproducing style in the patent in
suit. I conceive it to be my duty as an expert, so
far as my ability extends, to place the Court in
possession of all the information that I may
possess that is pertinent to the issue and clearly
responsive to questions addressed to me by counsel.
I was actuated in making my answer purely by a
disposition to do my full duty in this case.

274 XQ88. You have not yet stated where in the patent in review there is the remotest suggestion of such disarrangement of the machine whereby the record disk is not given its translatory movement. It is this point that the preceding question emphasizes and which you entirely neglect in your answer. Please state now when this idea that in the machine constructed in accordance with the patent the translatory movement of the tablet may be arrested occurred to you, and whether you find in the patent any intimation of such possibility?

275 A. As near as I can remember, this idea that provision was made for allowing the reproducer to follow the record even in case the tablet failed (by reason of any disarrangement of the machine) to have its translatory movement imparted to it, occurred to me the first time I read the patent No. 341,214. This was a good while ago and I cannot undertake to accurately fix the date. I know it was long before I ever saw a gramophone. The specific disarrangement mentioned in your question, is not described in the specification, but the clause of the specification included between lines 68 to 84, page 4, which I have quoted, is such as to readily include the specific disarrangement which I have given as an example; and as I have previously stated, such disarrangement occurred to me I think the first time I read the patent and was suggested to me by this very clause of the specification.

276 XQ89. When for the first time did you express your view of the possibility of the prevention of the rectilinear translatory movement of the record disk of the patent No. 341,214, in the course of this testimony?

A. I do not at this moment recall any mention of such a specific disarrangement prior to my answer to XQ86.

XQ90. You have heretofore made an affidavit in this case in support of complainant's motion for a preliminary injunction. Did you not?

A. I have.

XQ91. That was a carefully prepared paper, I suppose?

A. I undertook to prepare it with proper care.

Q. Did you in that affidavit intimate that in a machine constructed in accordance with patent No. 341,214, there may be such disarrangement as will prevent the record tablet to have its rectilinear translatory motion?

A. I did not.

XQ92. Have you on other occasions testified with respect to patent No. 341,214?

A. I have.

XQ93. Have you in any of that testimony stated or indicated that there may be such disarrangement in a machine constructed in accordance with the said patent as will prevent the record disk to have its rectilinear translatory movement?

A. I could not undertake to say.

XQ94. I suppose you have access to printed copies of any testimony that you have heretofore given with respect to patent No. 341,214, or to most of it. If this is the case, will you during the recess which we shall now take, search in such testimony, for any statement on your part that the machine in question may be so disarranged as to prevent its record tablet from having the rectilinear translatory movement?

A. I am not sure that I have at my disposal printed copies of all the cases in which I have testified with regard to patent No. 341,214, and in any event it would be too laborious an undertaking to go through all of my testimony in previous suits without a great deal of time at my disposal.

XQ95. Please point out in the drawing of patent No. 341,214, the device or devices shown by reason of which the reproducer may have a movement parallel with the face of the record tablet?

A. Referring to Fig. 8 of the patent, 29 is the head or block of the reproducer having a tube 31

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280 projecting therefrom. This tube 31 is joined to a second tube 33 by a section of soft flexible vulcanized rubber tubing 32. In the act of reproducing, the tube 33 is slipped into the tube 19, shown in Fig. 1. The reproducer when so placed has a mounting composed of rigid tube 31, flexible tube 32 and the rigid tubes 33 and 19; and the patent states in lines 60 to 62, page 4, that "in consequence of the flexibility of the rubber tubing 32 it" (meaning the reproducer) "is free to follow the record." The device by reason of which the reproducer may have a movement parallel with the face of the tablet is the flexible rubber tubing 32.

281 XQ96. The same rubber tube is also indicated in Fig. 13 of the drawings. Is it not?

A. The rubber tubing 32 is shown in Fig. 13. I would note, however, that in Fig. 13, it is the recorder H which is in operative relation with the tablet, the reproducer K being thrown out of operative position.

XQ97. Now as regards the flexible tube 32, it is, for the purpose of permitting the reproducer to move parallel to the face of the record tablet, flexible only to the extent as it does not embrace either the rigid tube 31, or the rigid tube 33; that is to say only in so far as it extends between the ends of these rigid tubes. Is this correct?

282 A. The tube 32 is flexible throughout its entire length. Of course when the tubes 31 and 33 are inserted within the tube 32, that portion of the tube 32 surrounding the rigid tube could not flex.

XQ98. Will you now please state as nearly accurate as you can from the drawing of the patent, how long that portion of the tube 32 is that is not slipped over the rigid tube and that can flex?

A. Without knowing the scale to which the drawings are drawn, it would be impossible to answer the question.

XQ99. Can you find anything in the specifica-

tion that will throw light upon this subject, namely 283
upon the length of the tube 32 that can flex?

A. The only places in the specification which I now recall without rereading the entire patent, wherein mention is made of the rubber tubing 32, are in lines 92 to 100, page 1, which says:

"Practically in the instruments made by us the pressure is due to the weight of the instrument, modified by the elasticity of a section of soft rubber tube which supports the same and constitutes a universal joint, but evidently there are many devices which can be used to mount the reproducer, so that it is free to follow the sound-record or phonogram, and which, therefore, would be within 284
the scope of the invention."

And in lines 52, 55, page 4, where it says:

"The tube 31, fixed at the upper end to the block 29, is joined at the lower end to the tube 33 by a section of soft, flexible vulcanized rubber tubing 32."

And on the same page, lines 58 to 62, the specification states:

"The reproducer K, when so placed is mounted upon a hollow standard composed of the tubes or tubing 31, 32, 33 and 19, and in consequence of the flexibility of the rubber tubing 32 it is free to follow the record." 285

Furthermore on page 4, lines 79 to 84, the specification states:

"It will be seen that the reproducer is mounted on a universal joint, so that it can move in any direction. The movement parallel with the face of the tablet would, however, by itself allow the style to follow and adjust itself to the record to a useful extent."

While none of these passages quoted specify the exact length of the flexible tubing 32, nevertheless I gather from them that it is to be of such length as to enable the reproducer to follow the

256 record, or as it is twice put in the specification leave the reproducer "*free to follow the record.*" (Italics mine.)

I also find in the claims of the patent ample justification for my assumption that the rubber tubing (when that form of universal joint is employed) is to be of such length as to leave the style free to move laterally and follow the record. This is particularly emphasized in Claims 19, 20 and 22.

XQ100. Could you not have briefly answered the preceding question by saying that the specification conveys no idea as to the length of the rubber tubing 32 that can flex?

257 A. I answered the question in what I considered a proper way.

XQ101. Well, then, I shall ask you again whether you can find in the specification any statement that says or conveys an idea of the length of that part of the rubber tubing 32 that can flex?

A. I stated in my answer to XQ99 that none of the passages quoted, and which to the best of my knowledge are the only passages mentioning tube 32, stated the exact length of the flexible tubing 32, nor do they specify the length of the portion which is free to flex when the tubes 31 and 33 are inserted therein.

258 XQ102. Supposing now the machine were constructed with the parts so dimensioned as they are shown in the drawings and particularly with the rubber tubing 32 just as shown in the drawings. To what extent, in your estimation, would then the reproducer style point be free to move parallel with the face of the record tablet?

A. It would be free to have a very considerable amount of lateral movement, but exactly how much it would be impossible to state in the absence of specification as to the thickness of the rubber tube and the distances within which the tubes 31 and 33 are inserted. The drawings as they appear in the reduced photolithographs, constituting the

patent office copies of the patent, are on so small a scale that the thickness of the rubber tube and even the insertion of the tubes 31 and 33 is somewhat difficult to determine. However, I note that the specification of the patent says on page 6 that it is not the intention of the patentees to limit the invention to the precise dimensions and proportions stated, and I therefore understand that it is the intention that the flexible tubing 32 should be given such proportions as would leave it free to follow the record in the manner described in the specification. 289

XQ103 Seeing that the specification does not state any dimensions as respects the rubber tubing 32, it is of course but natural that the description does not limit the patentees to any particular length or thickness of rubber tubing. But the specification says, in a passage which you have frequently quoted, that the movement parallel with the face of the tablet, due to the universal joint, would by itself allow the style to follow and adjust itself to the record "to a useful extent." Now, does the specification convey any idea as respects the "useful extent" of the parallel movement of the reproducer? 290

A. In three of the four passages quoted by me in my answer to XQ99 occurs the statement that the reproducer is "free to follow the sound record" by reason of its flexible or universal mounting. In one of these, the one to which you referred in your last question, is the statement that it is not only free to follow, but also to adjust itself to the record, and in this statement occurs the expression to a useful extent. There is nowhere in the specification, so far as I am aware, any definition of what is meant by the expression "to a useful extent," but I observe, as I mentioned before, that in other parts of the specification the explicit statement occurs that the reproducer is "free to follow the record," without any limitation 291

292 whatever as to the extent. I therefore take it, reading this expression in the light of the entire specification, that the patentees intended that the reproducer should be free to follow the record to such an extent as might be found useful or desirable in the operation of the machine.

XQ104. The language of the specification that requires that the reproducer be free to have a movement parallel with the record would be applicable to a case where that freedom extended only to one one-thousandth of an inch, as well as to the case where it extended to a space of five feet. Is it not so?

293 A. No, sir. If the reproducing style could move laterally but the one one-thousandth of an inch, it would not be "free to follow the sound record or phonogram" as stated in line 99 page 1, nor would it be "free to follow the record" as stated in line 62 page 4. A record consists of a solid substance having a sound groove formed therein, generally, and as shown in the specification, in the form of a spiral, covering some appreciable extent of surface, and if the reproducer is to be "free to follow the record," as it is repeatedly stated in the specification it is, it certainly must have a movement exceeding one one-thousandth of an inch. Of course your suggestion of a movement to the extent
294 of five feet is a gross exaggeration and one that would not be possible with complainant's construction nor called for in the practical art.

XQ105. We shall inquire into the meaning of the style being free to follow the record by and by; but since you seem to have no idea of the dimensions of what you call complainant's construction, it is not quite clear why five feet freedom of lateral movement is any more exaggeration than the like freedom to the extent of one one-thousandth of an inch.

Now while the description of the patent says nothing about the dimensions of the rubber tubing

32, the drawing certainly says something about it, and you have given it as your opinion that the lateral movement which the stylus point may have in the construction shown would be considerable. Now how considerable do you think it would be? 295

A. I stated in answer to a previous question that it would be impossible to state the extent of the movement due to the flexibility of the rubber tubing from the data furnished by the drawing alone, also pointing out that the drawing of the patent office copies are much reduced in photolithographing, but called attention to the fact that in view of all that was said in the specification that I regarded the reproducer as designed to have such lateral movement, due to the flexible tubing or other universal joint, as would enable it to follow the record to any extent that might be found useful or desirable. This is as definite as I can make my answer and I see no reason for changing it. 296

XQ106. Mr. Cameron, you are supposed to be quite familiar with the commercial graphophone or phonograph, and I will ask you to state whether in these commercial instruments that are placed upon the market by complainant there is or is not a construction of universal joint for the reproducer by reason of which the reproducer head and stylus are free to move laterally parallel to the face of the record tablet? 297

A. There is.

XQ107. Have you ever measured the extent of lateral movement that the reproducer head is free to have in such commercial instruments, and if so, please state how far it or any part of it is free to move laterally?

A. The reproducer head in the graphophone has a universally jointed mounting which leaves the reproducer and its style free to move laterally to an extent sufficient to allow it to be moved laterally across several of the spirals of the record

208 groove. In the commercial phonograph and
graphophone of to-day the records are in the form
of a cylinder having the sound groove cut in the
form of a spiral on its outer surface, these
cylinders being about two inches in diameter.
For the sake of compactness the reproducer is
mounted on quite a short stem and instead of the
record moving in a right line past the point of the
style the cylinder has rotary movement only and
the style is moved in a right line relative to the
cylinder. In view of the short stem upon which
the reproducer is mounted and the small diameter
of the record tablet, together with the desirability
209 of having the reproducer bear with substantially
uniform pressure upon the record, it would be
undesirable to permit the reproducer to have
lateral movement to any great extent to one side
or the other, or it would tend to slide down the
surface of the cylinder. As I have previously
stated, however, the reproducer has lateral move-
ment independent of the translatory movement
imparted to it past the record, such lateral move-
ment being sufficient to permit it to follow the
spiral sound groove on the cylinder even in the
cases where, through the disarrangement of the
devices which propel the reproducer as a whole,
the translatory movement of the reproducer is
300 interrupted. I have repeatedly thrown the repro-
ducer out of engagement with the screw which
imparts the translatory movement to it, and have
observed that even in this construction the repro-
ducer still follows the spirals of the record for
several turns.

All that part of the preceding answer
that follows the first sentence thereof is ob-
jected to as irresponsible.

XQ108. What number would you assign to the
"several" spirals throughout which the reproducer
head is free to move laterally?

A. I have found it to vary somewhat in different machines, or in the same machine with different reproducers. I remember on one occasion to have counted three turns of the record tablet before the reproducer point failed to track, the reproducer carriage being thrown out of engagement with its propelling screw and held stationary. 301

XQ109. What distance in inch measure would this make?

A. I think the spirals are cut in the neighborhood of one hundred to the inch, and a movement of three spirals to each side of the medial position of the reproducer would give six one-hundredths of an inch, approximately speaking. 302

XQ110. Have you any reason to believe that the freedom of lateral movement about the universal joint or rubber tubing of the reproducer style in the construction of machine shown in patent No. 341,214 would be any greater than that in the commercial machine?

A. Yes, sir, for the reasons given in my previous answers and from the entire disclosure in the patent No. 341,214, I have no hesitation in stating that in a machine constructed as described and illustrated in the patent the reproducer may have such lateral movement as will leave it free to follow the record to any extent that may be found useful or desirable. 303

Adjourned to June 14th, 1899, at 10:30 a. m. at the request of counsel for defendants.

Washington, D. C., June 14th, 1899.

Met pursuant to adjournment.

*Present—PHILIP MAURO, Esq., of counsel for complainant.

GUSTAV BISSING, Esq., of counsel for defendants.

Adjourned to Friday, June 16th, 1899, at the request of counsel for defendants.

304

Washington, D. C.,
July 26th, 1899, 10:30 a. m.

Met pursuant to adjournment and subsequent agreement of counsel.

Present—JOSEPH LYONS, Esq., of counsel for defendants.

PHILIP MAURO, Esq., for complainant.

Mr. Lyons continues cross examination of Mr. Cameron.

305 XQ111. I now call your attention to Patent No. 341,214 in suit; and more particularly to page 4 lines 58 to 67. You will there find, it pointed out that owing to the flexibility of the rubber tubing 32 no special care is necessary to insure the adjustment of the reproducer K, since when the latter is allowed to rest against the record with the style upon the engraved line, the style will of itself gravitate to the bottom of the groove. I will now ask you how much lateral movement expressed in inch measure the style would have when gravitating in the manner indicated to the bottom of the groove?

306 A. In the first place I do not find in lines 58 to 67 page 4 of Patent No. 341,214 the statement alleged in your question to be included in those lines. I find therein two statements which in framing your question you have read together taking a portion from each statement. The lines quoted contain first the statement that

“in consequence of the flexibility of the rubber tubing 32 it” (meaning the reproducer) “is free to follow the record.”

I then find the second statement as follows:

“No special care is necessary to secure its” (meaning the reproducer) “adjustment, for if the reproducer K be allowed to rest against the record with the style upon the engraved line, the style will of itself gravitate to the bottom of the groove.”

It will thus be seen that the patent indicates two results due to the flexibility of the rubber tubing 32. One is that it is "free to follow the record;" the other is that no special care is necessary to insure adjustment of the reproducer. These two results are very closely related as the adjustment of the reproducer may be either laterally or vertically, in the former case, it being to a certain extent the same as the freedom which permits the reproducer to follow the record. The last sentence in the lines quoted, however, lays particular stress upon the adjustment which allows the point of the reproducing style to rest upon the surface of the engraved undulations in the bottom of the groove. I understand the last part of your question to refer to the amount of lateral movement involved as the style is in the act of settling to the bottom of the groove. This would depend entirely upon the size and character of the style employed and the particular point upon the tablet where the style first rested when placed in position thereon. For example if when the reproducer were originally placed in contact with the record the style rested immediately upon the bottom of the groove, no lateral adjustment would be necessary. On the other hand, if it were placed on the upper or outer edge of the groove, in adjusting itself to the bottom of the groove it would necessarily have a lateral movement equal to one-half of the width of the groove. In different records this varies considerably, so that without more accurate data than that given in your question it would be impossible to give an exact answer.

XQ112. Please take the case of the ordinary commercial graphophone with which you are so familiar, and state how much lateral movement, at the maximum, the style would have to have when gravitating down to the bottom of the groove?

A. The records ordinarily used in the commercial forms of the graphophone of the present day are

310 of two styles, the smaller record to which I have heretofore referred has the record grooves cut about one hundred to the inch; those known as the "Grand" record have, I believe, a somewhat wider record groove. Where the record grooves are cut one hundred to the inch, if the groove was of the full possible width it would be the one one-hundredth of an inch. This, however, varies greatly, the groove being of irregular or varied form much wider in some places than in others. If, however, the groove was a full one one-hundredth of an inch, the style in gravitating from the upper outer edge of the groove to the medial line in the bottom of the groove would have a
311 lateral movement of one two-hundredths of an inch.

XQ113. And in thus moving laterally to the extent of one two-hundredths of an inch, the style would "follow the record." Is this not so?

A. It is not.

XQ114. What other kind of lateral movement do you find indicated in the patent here under consideration? Please point out specifically where you find in the patent indicated another kind of lateral movement of the style than that which it has when it gravitates to the bottom of the groove?

312 A. It has a lateral movement parallel with the face of the tablet which will allow it to follow the record. The record as described in the patent is in a spiral form on a plane surface, and the only other form of commercial record with which I am familiar is a spiral record on a cylindrical surface. In either the flat or the cylindrical form of record the spiral necessarily advances a certain distance along the surface of the disk or cylinder, and in order that the reproducing style may follow in this advance of the record groove over the recording surface, the patent describes the reproducer as being mounted upon a universal joint. It also points out that such universal mounting enables

the reproducer to adjust itself to the record, thus 313
constituting a decided advance over the prior
Edison reproducer which had to be very carefully
adjusted by hand. I find in several places in the
patent which I have previously quoted, reference
to this free mounting of the reproducer whereby it
is enabled not only to follow the record, but to
adjust itself automatically thereto. I find it
stated that the free mounting is to enable the re-
producing style to be readily guided by the record
so that it is free to follow the sound record. If a
reproducer style were allowed to rest upon a sound
record which was not in motion the weight of the
reproducer head would cause the style to slide 314
down the sloping wall of the sound groove until it
reached the bottom or medial line thereof thereby
automatically adjusting itself to the record groove,
or as the patent states, it has gravitated to the
bottom of the groove. We have here an adjust-
ment of the reproducer to the sound record which
involves, it is true, a slight lateral movement, but
does not involve any guiding of the reproducer
style by the record groove, nor can the style be
said to follow the record. If now, with the style
thus in position in the bottom of the groove, the
record be set in motion, the style will follow the
spiral groove and if, as in certain commercial 315
forms of the graphophone, the spirals advance at
the rate of one one-hundredth of an inch per
revolution, the reproducer will have a lateral move-
ment of one one-hundredth of an inch per revolu-
tion following the spirals of the sound groove.

On page 1, lines 84 to 86 the patent states:

"The invention consists, fourthly, in loosely
mounting the reproducing style so that it can
readily be guided by the record."

Lines 96, page 1, to line 3, page 2, the patent
says:

"But evidently there are many devices
which can be used to mount the reproducer.

316 so that it is free to follow the sound-record or phonogram, and which *therefore*, would be within the spirit of the invention. The reproducing style mounted as just explained is specially adapted for use in connection with a record in the form of a groove with sloping walls, and this combination is specially claimed, but it may also be usefully employed in connection with other forms of record."

On page 4, lines 58 to 67, I find it stated that

317 "The reproducer K when so placed is mounted upon a hollow standard composed of the tubes or tubing 31, 32, 33, and 19, and in consequence of the flexibility of the rubber tubing 32 it is free to follow the record."

On the same page lines 79 to 84 inclusive, the specification says:

"It will be seen that the reproducer is mounted on a universal joint, so that it can move in either direction. The movement parallel with the face of the tablet would, however, by itself allow the style to follow *and* adjust itself to the record to a useful extent."

318 In these quotations the italics used are mine. I find that the patent itself makes a distinction between following the record and adjusting itself (that is the reproducer) to the record. It states that the construction allows "the style to follow *and* adjust itself to the record." I find that it speaks of the style as being "free to follow the record" and also speaks of adjustment of the reproducer. I find that the reproducer is said to be loosely mounted "so that it can readily be guided by the record," and inasmuch as the guiding action is one that takes place after the proper adjustment is secured, and must take place during proper adjustment in order to secure satisfactory reproduction, it is very clear that by the expression "guided by the record" the patentees did not intend to convey the idea of the mere lateral

adjustment of the reproducing style as it gravitated 319
down the sloping walls of a record groove.

The patent makes it very clear that the universal mounting of the reproducer is not designed alone for permitting the co-operation between the reproducing style and the sloping walls of the sound record, for it specifically points out that the universal mounting may be usefully employed in connection with other forms of record than those with sloping walls. Furthermore, the portions of the specification which I have quoted, and especially that portion included between lines 96 and 101, page 1, makes it very clear that any device which is used to mount the reproducer so that it 320
is free to follow the sound record is for that very reason within the spirit of the invention. It says:

"There are many devices which can be used to mount the reproducer, so that it is free to follow the sound record or phonogram, and which, therefore, would be within the spirit of the invention."

I think from the portions of the specification which I have quoted that it is very clear that the patentees designed the universally jointed reproducer to be free to be guided by or to follow the record groove as it advanced spirally and also to have the additional function of adjusting itself 321
down the sloping walls of a record groove thus formed.

XQ115. If I understand the gist of your answer correctly, it is to the effect that the patent gives to the universal mounting of the reproducer two distinct functions; one being the automatic adjustment of the style to the bottom of the groove, which involves a slight lateral movement of the style; and the other being the freedom of the style to "follow the record" or to be "guided by the record" by which you understand a greater lateral movement than is involved in the automatic adjustment of the style to the bottom of the groove.

322 Have I thus correctly understood the gist of your last answer?

A. That is substantially correct.

XQ116. And your warrant for holding that the patent distinguishes between the lateral movement involved in the automatic adjustment of the style and the lateral movement involved in the act of following the record, you find in the passages which you have quoted in your last answer. Is this correct?

A. When taken in connection with my knowledge of the operation of the devices, it is.

323 XQ117. You rely then not entirely upon what the patent says or shows, but you depend largely upon what you call your knowledge of the operation of the devices, for establishing a distinction between the lateral movements referred to?

A. The patent is addressed to those skilled in the art of recording and reproducing sounds, and it is intended to be understood by those to whom it is addressed as disclosing the construction with such minuteness that it would enable those skilled in the art to readily understand, construct and use, the device described. I believe myself to be fairly entitled to be included in the class of those skilled in the art of recording and reproducing sounds, and when I stated that I got my understanding from the patent coupled with my knowledge of the operation of such devices, I think I stated the conditions which the patentees and the law presumed to exist in order to enable the patent to be fully and clearly understood.

324 XQ118. But when this patent in question was first published to the world, you had no knowledge of the operation of a universally jointed sound reproducer. In other words, your knowledge of the operation of these devices came to you afterwards. I presume you will assent to this?

A. Of course the knowledge which the world received of the construction and operation of these

specific devices described in the patent was given to the world through the patent, but the knowledge which the world possessed at the date of the patent in regard to the art of recording and reproducing sound was to be used in understanding and interpreting the description of the patent. For example, the patent states that the universally mounted reproducer style is especially designed for use in connection with a record groove having sloping walls, but it states that it may also be usefully employed with other forms of groove. Those skilled in the art and to whom the patent is addressed being familiar with other forms of sound-grooves than that with sloping walls, readily comprehended that the function of the free lateral mounting of the reproducer, was not alone limited to permitting the reproducer style to slide down the sloping walls of the groove, but that it had useful functions even where there was no sloping wall. I would not be understood, as the question seems to indicate, as referring to the specific devices described in the patent, when I speak of the operation of the devices, but as referring generally to the operation of devices employed in the art of recording and reproducing sound.

XQ119. When the style automatically adjusts itself to the record by sliding down the sloping wall of the record groove, it is in its movements guided by that sloping wall, is it not? 325

A. Possibly it might be said to be guided by the sloping wall, but such sloping wall does not constitute the record nor does the patent mean, as I understand it, the sloping wall of the groove when it says that the style is free to follow the sound record. 326

XQ120. Is it, or is it not the fact, that the elevations and depressions of which the patent under consideration speaks as the sound record are found not only at the bottom of the groove, but also in the sloping walls although they are more pronounced at the bottom of the groove? 327

328 A. In order to form a sound groove with sloping walls the style is necessarily more or less pointed, the patent describing one form as being made from a round wire by turning the end conical and rounding off the extremity, thus leaving a tapering point, the sloping walls of the sound record take the form of the tapering point of the recording style. If the style penetrates deeply into the record material the groove will be widened materially, and if in the return swing of the diaphragm in the vibration the style rises to near the surface of the recording tablet in order to form an undulation, the groove not only becomes shallower, but
329 likewise narrower, being only so wide as the distance across the point of the style at the surface of the material. A sound groove therefore, when formed with a tapering style, or when formed with a style somewhat more rounded than could be properly included in the term conical, has undulations which vary in depth and also has formed in its opposing side walls undulations which approach and recede from each other as the sound groove is shallower or deeper. I should, however, hesitate to say that the undulations at the bottom of the groove were any more pronounced than the undulations in the side walls of the groove. In fact, in the groove as practically formed it would
330 be impossible to state where the side walls of the groove ceased and the bottom of the groove began.

XQ121. From your last answer it would appear that you find the sound record just as well, or nearly as well, pronounced on the sloping walls as on the bottom of the groove. This being the case, is it not proper to say that when the style gravitates down to the bottom of the groove when it automatically adjusts itself to the record, that it is guided by the record and follows the record down to the bottom of the groove?

A. No, sir. It would be an exceedingly narrow and strained construction of the wording contained

in the description of the patent in suit to so construe it. 331

The track of the reproducer as it gravitates down the side wall of the record groove cannot be said to follow the record. The record consists of a series of undulations which, in the vertical form of record, are elevations and depressions or other inequalities corresponding more or less perfectly to the forms of sound vibrations, and a mere line drawn down the side wall of the record groove could not be said to be a line which followed the record, nor could such a line down one of the side walls of the groove be said to be the record. The record is made up of undulations and it is very clear to my mind that when the patent speaks of the style as having lateral movement which permits it not only to follow the record, but to adjust itself to the record, that by one it means that adjustment which would bring the recording style into proper operative relation with the sound groove, and that by "follow the record" is meant that the style shall remain in such operative relation with the record groove as the same is given motion past the style. I think this is brought out in that part of the patent wherein it states that while the style is specially adapted for use with a groove with sloping walls, it may also be usefully employed in connection with other forms of record. 332 333

XQ122. Now please consider the record tablet moving and while so moving consider the performance of the stylus when it adjusts itself to the record by sliding down the sloping wall. Does not in that case the style bear from moment to moment upon different portions of the sloping wall over and past the undulations in the same; and is it then not proper to say that when the style gravitates down to the bottom of the groove when it automatically adjusts itself to the record, that it is guided by the record and follows the record?

A. The record groove is only about the one-

334 thousandth part of an inch deep, and when the record is in motion the style would settle down in the groove so quickly, having only the one-thousandth part of an inch to move downward, that the advance of the record under the style during the time which is occupied by the style in gravitating to the bottom of the groove would be practically imperceptible. At the most the track of the style on the side wall of the groove would be but very slightly withdrawn from the vertical, certainly not to a sufficient extent to make it proper to say that it followed the record. In other words the adjustment of the style down the side walls of the groove is practically instantaneous and during
335 such act of adjustment does not therefore move to any appreciable extent in a longitudinal direction along the groove.

XQ123. Now, Mr. Cameron, it is quite clear that we have here to do with exceedingly small quantities; with a record groove about one one-hundredth of an inch wide and about one one-thousandth of an inch deep, and with small fractions of a second of time during which certain movements take place. Still the patent speaks of the movement of the style down the sloping walls to the bottom of the groove, and you have spoken of this yourself. We are therefore not permitted in this examination
336 tion to despise and to neglect small quantities. Please therefore, state whether, as a mathematical conception, which has nothing to do with size, is it not true that when the style adjusts itself automatically to the record, the record tablet being in motion, the style is guided by the record and follows the record?

A. Once the style has become adjusted in the proper operative relation with the record, viz., a groove in the form of sloping walls, it would be guided by and would follow the record, but in the act of adjustment, that is in the act of gravitating to the bottom of the groove, or until it reaches the

bottom of the groove, it certainly would not be guided by nor could it be properly said to follow the record. The patentees describe as one specific form of record a groove with sloping walls, and if, when they speak of the reproducing style being guided by the record, or as being free to follow the record, they had meant but one side wall of the record groove they certainly would not have used the expression "sound record or phonogram," but would have said just what they meant. Inasmuch as they do not say that the reproducing style is guided by the sloping side walls of the record groove, but do state that it may be readily guided by the *record*, and that it is free to follow the *record*, I am very clear that they did not mean the act of the reproducer in gravitating to the bottom of the groove. This is especially apparent in a patent like the present one which has evidently been drawn with great skill and exactness, so as to clearly and specifically define exactly what the patentees mean. 337 338

XQ124. It is your opinion then, that the specification of this patent is particularly accurate in expression, and states exactly what the patentees mean without ambiguities?

A. I regard the patent as exceptionally clear and well drawn.

XQ125. Supposing now the style having adjusted itself automatically to the record at the bottom of the groove; and suppose that by some irregularities in the mechanism the style did not faithfully remain at the bottom of the groove, but developed tendencies from moment to moment to ride up the sloping wall; would not the universal joint upon which the reproducer is mounted allow the style to counteract that tendency to ride up the sloping walls and bring it back again to the bottom of the groove, keeping it at the bottom of the groove, and thus be from moment to moment guided by the sloping walls to the bottom of the 339

310 groove, so that it may follow the same, that is the record?

A. Undoubtedly.

XQ126. Now, in this operation is not the style guided now by one sloping wall and now by the other, to the bottom of the groove; and is this not all the guiding there is?

341 A. Possibly the irregularities might be such as to cause first one side and then the other side of the groove to act upon the style, or rather to have the style slide down upon first one side and then the other; but I do not conceive this by any means to be all or the main guiding action which the style receives from the record groove. Owing to the spiral formation of the record the style is or may be moved along by the rear side of the groove and yet be at all times in perfect contact, not only with the bottom of the groove, but with both sides thereof. Even in the absence of the assumed irregularities the style is guided by the groove, or follows the record, for in the sense in which they are used in the patent, the expressions free to be "guided by the record" and free to "follow the record" are to be read as exact equivalents.

342 XQ127. How about the expression "adjust itself to the record," or "automatically adjusting itself to the proper place on the record," are these also the exact equivalents of the phrases "guided by the record" and "follow the record?"

A. I have already explained that when the style is placed upon the record, even when the latter is not in motion it will automatically adjust itself in the proper position in the record groove, so that the adjustment of the style automatically in the record does not necessarily involve any motion on the part of the record. In order that the style may "follow the record" or be "guided by the record" relative motion of the record past the style is implied. I certainly do not therefore regard the automatic adjustment of the style to the record

as being included in the expression "guided by the record" or "free to follow the record." 343

XQ128. Please again consider the style as having adjusted itself automatically to the bottom of the record groove; that by reason of some irregularities in the mechanism there is developed from moment to moment a tendency of the style to ride up one or the other walls. Further that by reason of the universal mounting of the reproducer this tendency of the style is counteracted by being free to slide down now one sloping wall and now the other, so that the style is kept always in the bottom of the groove and is prevented from riding up either sloping wall. Now in this case does your language which you used in your answer to XQ121 not fully describe the operation, namely, that the automatic adjustment to the record would bring the recording style into proper operative relation with the sound groove, and that in the manner I have described the style would "follow the record", in that it is forced to "remain in such operative relation with the record groove as the same is given motion past the style." In other words, does not your explanation of the meaning of the phrase "follow the record" apply exactly and precisely to the operation which I have here described of now one and then the other of the sloping walls acting upon the style, forcing the latter to remain in the bottom of the groove? 344 345

A. No, I do not so consider it. In the first place, there is only "a tendency" for the style to rise upward off of the bottom of the sound groove, and this tendency is counteracted, not by the sloping walls of the groove, as your question would seem to intimate, but by the weight or spring which holds the reproducer in constant contact with the undulations forming the sound record. If the record were one with vertical side walls and with the undulations in the bottom of the groove, and the recording style were in some way properly

- 346 adjusted in the groove, the same tendency which your question proposes for the style to rise off of the undulations might exist, and the style would, notwithstanding such tendency, be held in contact with the undulations by the weight or spring controlling the reproducer. The adjustment once secured is maintained by the weight or spring and by reason of the universal joint the style is free to follow the sound groove laterally. Now if the style were held in operative relation with the undulations of the groove, notwithstanding the "tendency" which your question supposes to exist, to rise upward off of the undulations, it would nevertheless be necessary for the style to have free lateral movement in order that it might follow the sound groove either by reason of any regular or irregular lateral variations in the direction of the groove. The distinction which I make between adjusting the style to the record and being guided by the record is this, that in one case the style is brought into operative relation with the record by adjustment either vertically or laterally, and that having secured such adjustment the style is guided by or is free to follow the record as the same moves along, thereby maintaining it in the position to which it has previously been adjusted. One supplies the condition through which it reaches proper operative relation with the record, the other supplies the conditions whereby it is maintained in such operative relation.
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- 348

XQ129. And the condition that the style is free to move laterally to the extent of one half the width of the record groove, that is to say one two-hundredths of an inch, is all sufficient for maintaining the style in proper operative relation at the bottom of the record groove?

A. No. The variations and irregularities in the movement of the record may, in a lateral direction greatly exceeding the one two-hundredths or the two one-hundredths of an inch. For example, any slip or

false movement of the parts which are designed to cause the record to travel past the point of the style might readily be of such a character as to permit the record to make several revolutions without any advance in a right line notwithstanding which the lateral movement of the style would enable it to follow the record. I fail to find anything in the patent that would limit the lateral movement described therein to the mere width or a portion of the width of the record groove. I conceive the universal joint to be designed not merely to give the reproducing style the very slight movement necessary to permit it to adjust itself down the side wall of a groove having sloping walls, but I also understand it to include the vastly greater lateral movement of the style which would enable it at all times to be free to follow the record and be guided thereby. 349 350

XQ130. The patent clearly speaks of the lateral movement of the style requisite for reaching the bottom of the groove from any point of the sloping wall, does it not?

A. It does not.

XQ131. Is this not expressed in the following sentence in the patent, page 4, lines 62-67:

"No special care is necessary to insure its adjustment, for if the reproducer K be allowed to rest against the record with the style upon the engraved line, the style will of itself gravitate to the bottom of the groove." 351

Does this not clearly describe the lateral movement from any point of the sloping wall of the groove to the bottom thereof?

A. If the engraved line were necessarily one with sloping walls, the style would, when gravitating to the bottom of the groove, as mentioned in that portion of the specification which you have quoted, have a slight lateral movement, but I regard this as a very different thing from "clearly speaking of the lateral movement of the style re-

352 requisite for reaching the bottom of the groove from any point of the sloping wall." This is an inference which may properly be drawn from the specification when the style is operating in connection with a certain specific form of sound groove, viz., one with sloping walls, but it certainly is not such an expression as could be included under the terms of your XQ130.

353 XQ131. At any rate, since the patent describes no other specific sound groove than one with sloping walls the "inference" seems to be a pretty obvious one, that the style shall have a lateral movement throughout one-half the width of the record groove. Will you now please point out in the patent the mention of any other specific lateral movement?

354 A. I do not know as I understand what counsel means by "specific lateral movement". The patent very clearly points out that the style is mounted on a universal joint; that by reason of such mounting it has a movement "parallel with the face of the tablet" and that by reason of such movement it is not only free to adjust itself to the record, but is free to follow the sound record and be guided thereby. The lateral movement therefore, as I have repeatedly heretofore stated, enables the style to perform two important functions, one the adjustment of the style to the record, the other the endowment of the style with that freedom of movement which enables it to be guided by and to follow the record.

XQ132. I thought that my question was tolerably clear but I shall now put it in another form. You have stated that the lateral movement of the style to the extent of one half the width of a record groove is not sufficient to permit it to follow the record, and that a vastly greater lateral movement may be required for this purpose. Now we have found that a lateral movement to the extent of one-half the width of a record groove is predicated

in the patent, as you say, by "inference." Now 355
the question is, where do you find in the patent
predicated that greater lateral movement that you
say may be required for allowing the style to
freely follow the record?

A. I have not stated that a lateral movement to
the extent of one-half the width of a record groove
"is not sufficient to permit it to follow the record."
A lateral movement of that extent might be suffi-
cient under certain conditions and circumstances
to follow the record; and again under other con-
ditions it might be wholly inadequate. I have
stated that I failed to find anything in the patent
that would limit the lateral movement described 356
therein to the mere width of a portion of the width
of the record groove. The joint is described as a
universal joint, and an arm having a universal
joint would have a very extended lateral move-
ment in the absence of anything specified as de-
signed to place limits upon such lateral movement.
No such limits are specified in the specification
and I therefore have no hesitation in stating that
a reproducer with unlimited lateral movement
would clearly fall within the description contained
in the patent.

Adjourned to Thursday, July 27th, 1899.

357

Washington, D. C., July 27th, 1899.

Met pursuant to adjournment.

Present: Parties as before.

Mr. Lyons continues cross examination of Mr.
Cameron.

XQ133. You have not yet answered my preced-
ing question, since you have not yet stated where
you find in the patent predicated that lateral
movement of which you say that it may be required
for allowing the style to freely follow the record.

358 You have found a lateral movement of the style to the extent of one-half the width of the record groove indicated; now point out where you find a greater lateral movement indicated in the patent?

A. I have already stated that I find in the patent a statement to the effect that the reproducing style is mounted on a universal joint. A style thus mounted would have free lateral and vertical movements. No limits specified in the patent to the movements thus resulting from the universal mounting, and in the absence of any construction which would necessarily limit the lateral movement due to the universal mounting, I am perfectly justified in assuming that the lateral movement
359 would be without limit; moreover, I find that the patent states that by reason of the universal mounting the reproducer is "free" to follow the record and to be guided thereby, and as the record advances in spirals the reproducer could not follow or be guided by the record unless it had lateral movement. I am in this answer not ignoring the fact that the patent provides means for giving the record motion past the point of the style, but point out the fact that the patent states, page 4, lines 68 to 71, that

360 "There exists always a liability to disarrangement in some part of the machine either in the recorder or the support therefor or the recording tablet or its support."

and the statement is specifically made that the lateral movement parallel with the face of the table would allow the style to "follow" as well as adjust itself to the record.

XQ134. You have not yet pointed out where a greater lateral movement of the style than to the extent of one-half the width of the record groove is predicated in the patent. Please do so, if you can?

A. There is in the specification of the patent no specific statement to the effect that the style has a

movement of just one-half the width of the record groove, but there is in the specification a statement to the effect that the style has a universal mounting and that it is enabled thereby to adjust itself upon the record. There is also a statement to the effect that it may not only adjust itself to the record but that by reason of the lateral movement due to the universal joint it may follow and be guided by the record groove. The conclusion that the style may adjust itself to the record and that it has a lateral movement greater than is necessary to allow it to adjust itself to the record, are both based upon identically the same statements in the patent, viz., that the reproducer is mounted on a universal joint and that it may, therefore, automatically adjust itself on the record as well as to follow and be guided thereby. 361 362

XQ135. You have not yet stated where in the patent a greater lateral movement than to the extent of one-half the width of the record groove is predicated. I do not ask you to point out in the patent a positive statement to the effect that such greater lateral movement may be called for in the operation of the machine; but I will be quite satisfied if you can point out anything in the patent that would by inference lead to the conclusion that such greater lateral movement was contemplated, or may become necessary in the operation of the machine. Please point this out, if you can? 363

A. On page 1 of the specification, lines 84 to 101, I find the following statement:

"The invention consists, fourthly, in loosely mounting the reproducing style so that it can readily be guided by the record. Preferably the reproducing style, or rather what may be called the 'head' of the reproducing instrument, is mounted on a universal joint, and the style is pressed against the record by the yielding pressure of a spring or weight. Practically in the instruments made by us the pressure is due to the weight of the instru-

364 ment, modified by the elasticity of a section of soft rubber tube, which supports the same and constitutes a universal joint; but evidently there are many devices which can be used to mount the reproducer, so that it is free to follow the sound record or phonogram, and which, therefore, would be within the spirit of the invention."

There are other portions of the specification which specifically describe the arrangement of the parts. Thus on page 4, lines 58 to 62 the specification states:

365 "The reproducer K when so placed is mounted upon a hollow standard composed of the tubes or tubing 31, 32, 33 and 19, and in consequence of the flexibility of the rubber tubing 32 it is free to follow the record."

And on the same page, lines 79 to 81, I find the statement:

"It will be seen that the reproducer is mounted on a universal joint, so that it can move in any direction."

I find claim 21 of the patent to read as follows:

"21. The reproducer mounted on a universal joint and held against the record by yielding pressure, substantially as described."

366 The portions of the specification to which I have referred disclose a reproducer mounted on a universal joint, and such reproducer would necessarily, in the absence of any specified means for limiting lateral movement, be endowed with unlimited lateral movement, and I find in the patent nothing that would limit the lateral movement of the style within the portion of the surface of the tablet within which the sound grooves are engraved. In this connection I would point out that the old Edison tinfoil sound record was one having vertical undulations, and that the reproducing head was rigidly clamped so as to be held against lateral

movement and that the style which was attached to the vibratory diaphragm was adjusted on the record by hand before the head was clamped in position and thus held in its adjusted position and therefore could not follow the record. Bell and Tainter introduced two improvements over this construction; *first*, they mounted the reproducer upon a universal joint. This universal joint was useful (1) in enabling the style to be adjusted in position upon the record, and (2) it gave the style during the operations of the machine a free lateral movement which the Edison reproducing style did not possess. *Second*, for the purpose of maintaining the reproducing style in operative relation with the record when once it was adjusted thereto they applied yielding pressure thereto in the form of a spring or weight. The passages I have quoted from the specification of the patent clearly indicate that the reproducing style was held in proper operative relation when the adjustment was secured by such spring or weight, and that in addition thereto the style was permitted to follow or be guided by the record by reason of the universal mounting.

The answer is objected to by counsel for defendants as irresponsible and as a voluntary attempt of giving testimony in chief for the complainant when nothing in the question justified or led up to such an attempt.

XQ136. Now Mr. Cameron, you are a solicitor of patents and you have repeatedly testified in patent causes. I presume that you understand the meaning of a question if it is expressed with tolerable clearness. I will therefore now ask you whether you can, or cannot, point out in the patent here under consideration, any statement that either says or leads to the inference that in the operation of the machine described a greater lateral

370 movement of the style than to the extent of one-half the width of the record groove may be required. This question I believe can be answered categorically.

A. Without undertaking to point to any specific paragraph further than those quoted in my last answer, I have no hesitation in stating that the operation of the mechanism described in the patent would necessarily call for a greater lateral movement on the part of the reproducing style than to the extent of one-half the width of the record groove. The patent as a whole must be read in the light of the then existing art and in my judgment should be read as a whole rather than in segregated parts or statements. Thus read, I repeat
371 that I have no hesitation in stating that the patent contemplates a greater movement on the part of the reproducing style than one-half the width of the record groove.

XQ137. You are skilled in reading and interpreting descriptions of inventions. Please therefore explain, so that it may be understood by the Court how and in what manner it appears from the description in the patent as a whole that in the operation of the machine a greater lateral movement of the style than to the extent of one-half the width of the record groove is or may be required?

372 A. As I understand it, every patent must be interpreted in view of the prior art, that is, the art prior to the date of the invention described by the patent. In my answer to XQ135 I pointed out that the art as it existed at the date of the patent No. 341,214 in suit was illustrated in what was probably its then highest perfection by the Edison tinfoil phonograph, in which the reproducer was adjusted by hand with the reproducing style in operative relation with the undulations constituting the sound record, and then clamped rigidly in position so that it was unable to move in any direction except such movement as was permitted by the

diaphragm to which the style was attached. The 373
difficulties due to this construction were, *first*, that
it required exceedingly skillful manipulation, far
beyond the ability of the ordinary operator to se-
cure the necessary nicety of adjustment; and
second, when the adjustment was secured, any
slight irregularities in the mechanism would ren-
der it impossible for the reproducing style to fol-
low the record groove. This inability of the re-
cording style to follow the groove, and the exceed-
ing nicety of adjustment required, made the
reproduction of a removable record, if such at that
time had existed, practically an impossibility
because it would be beyond the skill even of the 374
most expert manipulator to remove a record and
again replace it upon the machine with such ex-
actitude as to make it possible for the reproducing
style to track in the groove. This difficulty of
adjustment, and the desirability of providing a
machine which would render the reproduction of
removable records a possibility, was one of the
great demands of the art at the date of the Bell
and Tainter patent in suit. Bearing this condition
of the state of the art in mind, I think the portions
of the specification which I quoted in my answer
to XQ135, very clearly demonstrates that the in-
ventors had in mind the production of a reproducer 375
so mounted that it would readily accomplish two
objects, one, the automatic adjustment of the style
into operative relation with the undulations of the
sound groove, and the other, provision whereby
the reproducing style would when once adjusted,
follow the record and be guided thereby even when
the particular position of the record upon the
machine varied from that which it occupied when
the record was originally formed, thereby enabling
removable records to be made upon one machine,
taken off, and again placed either upon the same
or another machine and reproduced with the utmost
facility.

376 By mounting the reproducer upon a universal joint in the manner set forth in the parts of the specification from which I have quoted in answer to XQ135, they provided (in the specific form of record described) for that movement of the reproducer which was necessary to secure the adjustment of the style into operative relation with the undulations of the sound groove; and in order to hold or retain it in such operative relation, and yet at the same time permit it to yield to irregularities in the record other than those constituting the sound record, they provided for holding it yieldingly in place by means of a weight or spring.

377 In addition to this movement which the reproducer has in the act of adjustment into operative relation with the record, the universal joint upon which it is mounted gives it great lateral play, the same being such as would permit it to move entirely across that portion of the recording surface upon which the sound grooves are engraved. The portions of the specifications from which I have quoted clearly state that the reproducer is mounted upon a universal joint, that the object of this mounting is to enable the reproducer to be guided by the record so that it is free to follow the record. The movement of the style whereby it is enabled to "adjust" itself to the record is a partially lateral and partially vertical movement, supposing the style when originally placed upon the record not to have centered exactly upon the groove. The patent very clearly recognizes a distinction between the movement required by the style to adjust itself to the record, and the movement required by the style which enables it to "follow" the record. The patent says, lines 81 to 84, page 4:

378

"The movement parallel with the face of the tablet would, however, by itself allow the style to follow *and* adjust itself to the record to a useful extent."

This movement parallel with the face of the tablet is what we have all along been designating as a lateral movement, that is, a movement transverse to the lineal direction of the record groove, and the sentence which I have just quoted very clearly recognizes the fact that this movement is sufficient not only to enable the style to adjust itself to the record, but to also enable it to follow the record. I think that with this explanation it will appear that the portions of the specification which I have quoted make it plain that in the operation of the machine a greater lateral movement of the style than to the extent of one-half the width of the record groove is obtained.

379

XQ138. Is this last answer of yours intended as an explanation of how and in what manner it appears from the description in the patent as a whole that in the operation of the machine the greater lateral movement of the style than to the extent of one-half the width of the record groove is, or may be required?

380

A. It is intended as a statement in very general terms of the want in the art which the patent overcame and of the manner in which it overcame it, viz., by mounting the style upon a universal joint so that it is free to follow the irregularities of the sound groove other than those irregularities constituting the undulations of the record; and it is intended as a general statement of the fact that by giving the reproducing style a universal mounting without placing any necessary limit to the lateral movement secured thereby, that the patent necessarily describes a reproducer having such practically unlimited lateral movement as results from the universal joint, especially when such construction is taken in connection with statements in the specification that the style is free to follow the record and be guided thereby, and when in the more explicit part of the specification, such as the claims, the construction designed to be covered is

381

382 defined, as in claim 21, where is defined a reproducer mounted on a universal joint and held against the record by yielding pressure.

XQ139. Your answer to XQ137 was, from what you now say, not really intended to be responsive to the question. It so appeared to me without your statement to this effect. I shall therefore repeat XQ137 and will ask you again to explain, so that it may be understood by the Court, how and in what manner it appears from the description of the patent as a whole, that in the operation of the machine a greater lateral movement of the style than to the extent of one half the width of a record groove, is or may be required?

383

A. At the date of the patent in suit there was great difficulty in securing the proper adjustment of the style into operative relation to the undulations of the sound groove, and such adjustment being secured it had been found almost impossible to maintain such adjustment because the sound grooves almost invariably had irregularities other than the undulations constituting the record, irregularities which were due to imperfections in the construction of the machine, to changes of temperature and the like. These irregularities were in and of themselves sufficient to offer almost insurmountable difficulties, but when it was undertaken to introduce removable records into the art, the impossibility of securing the proper relations between the record and the style of the reproducer were found to be so great that no removable records had ever been employed. I understand these to be demands at that time existing in the art of recording and reproducing sound, which presented difficulties well known to the patentees at the date of the patent in suit, and as I have before stated I believe it to be but right and proper to interpret the patent in the light of the then existing state of the art. The patent states, in lines 75 to 83, page 1, that:

384

"The invention consists, thirdly, in cutting or engraving the record in the form of a groove with sloping walls, the sound waves being represented by elevations and depressions at the bottom of the groove or otherwise. The advantage of this form of groove is that it forms an efficient guide to the reproducing style."

385

The "form" of groove referred to is one with "sloping walls" and the patent recognizes the desirability of having the record groove guide the reproducing style by pointing out that a groove of this form affords "an efficient guide to the reproducing style." Manifestly, however, a style which is rigidly mounted cannot be efficiently guided, and the patent proceeds in the next statement as to the objects of the invention, to say that it consists:

386

"Fourthly, in loosely mounting the reproducing style so that it can be readily guided by the record."

I understand this to mean, when taken in connection with the third statement of invention, that the invention consists in providing a record groove with sloping walls which will afford an efficient guide for the reproducing style, and then in providing a style so loosely mounted that it can be guided by the record. The patent then proceeds to state that the loose mounting of the reproducer is preferably secured by the use of a universal joint, and the specific form of universal joint illustrated in the patent is that of a section of soft rubber tubing. This tubing, by reason of its flexibility, permits the reproducer to move laterally, vertically or otherwise, in any desired direction. Thus far, the patent has described a reproducing style mounted so as to be capable of being guided, and a suitable sound groove capable of forming an efficient guide to the style. It now proceeds to describe means whereby the style may

387

388 be automatically adjusted into operative relation with the record groove and when once so adjusted, may be held in such relation with yielding force.

It says, lines 90, 91, page 1:

"The style is pressed against the record by the yielding pressure of a spring or weight."

389 It further explains that this weight may be modified by the elasticity of the section of soft rubber tube, and that the weight may, if desired, be due to the instrument itself. The lateral movement whereby the styles enabled to be guided by the record is due to the universal joint; the automatic adjustment is due to the action of a spring or weight or other yielding pressure operating in conjunction with a reproducer provided with a loose mounting, such as the universal joint, or the section of soft rubber tubing. I think there can be no doubt that thus far the patent has very clearly described a reproducer so mounted as to be capable of lateral movement, and has not placed any limit of any kind whatever upon the extent of such lateral movement. In the absence of any statement that there is such a limit I certainly should not regard it as proper to read a limit into the patent.

390 The patent then proceeds, lines 96-101, page 1, to state that there are many devices which can be used to mount the reproducer so that it is "free to follow the sound record."

This is the first time the expression "free to follow the sound record" occurs in the specification, but I think there can be no doubt that this expression is meant to describe the same action that is indicated by the expression "readily be guided by the record."

While a sound groove with sloping walls is described as one having the advantage of forming an efficient guide to the reproducing style, the patentees are careful to point out that their

loosely mounted reproducing style is not designed to be used exclusively in connection with a record in the form of a groove with sloping walls, but add that "it may be usefully employed in connection with other forms of record."

391

I thereby understand that the patentees intended to state distinctly that their universally mounted reproducer was designed to be employed with any form of record groove which would enable it to be readily guided by the record, and that the employment of such an universally mounted reproducer in connection with any record groove which operated to guide the reproducing style, would fall "within the spirit of the invention."

392

On page 4, lines 58 to 62, a statement is made of the specific manner in which the reproducer is mounted upon the section of soft rubber tube, and it is specifically explained that "in consequence of the flexibility of the rubber tubing 32, it," meaning the reproducer, "is free to follow the record." I understand this to be a specific description of a construction which shall leave the reproducing style perfectly free to have such movement, lateral or otherwise, as may be necessary to enable it to at all times follow the record. Now as one of the difficulties existing in the state of the art the date of the Bell and Tainter invention was to preserve the reproducer in operative relation with the undulations of the sound groove after the same had been secured by such adjustment, and as the demand for removable records would necessitate a vast increase in the irregularities or variations which would make it difficult for the reproducer to follow the record, I think that the statement to the effect that the reproducer is *free* to follow the record means just what it says, that is, that it is unrestricted and is enabled to take such movement, lateral or otherwise, as may be necessary to enable it to follow or be guided by the record.

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In lines 79 to 84, page 4, I find it stated that the

394 reproducer is so mounted that it can move in any direction and that the movement parallel with the face of the tablet (which is what I understand the question to mean by "lateral movement,") would by itself allow the style to not only adjust itself to the record, but would also allow the style to follow the record. Here again we have a statement to the effect that the universal mounting of the reproducer is for the express purpose of permitting it to follow the record and in the absence of any limitation as to the extent of the movement parallel to the face of the tablet, I do not feel that it would be proper to read any limitation into the description. Without so doing, it is manifest that
395 the movement parallel with the surface of the tablet, which is, as I have before stated, a lateral movement, may be such as may be found necessary to enable the style to be guided by or to follow the record as has been described in other portions of the specification to which I have referred. Now, I have pointed out heretofore, that by reason of changes in temperature, irregularities in the operation of the mechanism of the machine, as well as by inaccuracies due to the formation of the record upon one machine, and in removing and placing it for reproduction upon another machine, that the irregularities tending to prevent the reproducing
396 style from following the record are very considerable, and that is was manifestly one of the objects of the Bell and Taiter construction to provide a reproducer which would follow and be guided by the record notwithstanding the theretofore serious and fatal irregularities. They very clearly indicate that their solution of the problem consisted in mounting the reproducer upon a universal joint so that it would be free to move in any direction and to any extent that might be necessary to enable it to be guided by or follow the record.

I have sought to make the answer as specific and as clearly responsive to the question as I know how, but if I have failed to make it as definite as counsel desires I will gladly explain further any point which counsel feels has not been already sufficiently elucidated. 397

XQ140. You have indeed not even touched upon the question which I asked. You have not even made an attempt to explain how and in what manner it appears from the patent that in the operation of the machine a greater lateral movement of the style than to the extent of one-half of the width of a record groove is or may be required. Please consider the simplicity of this question and if you can make answer thereto, without exploring the prior state of the art and what these patentees achieved and what great inventions they made? 398

A. I have to ask counsel to point out specifically wherein my answer to the preceding question fails to respond to the question, and if I am able to do so I will, upon such specific indication of the points which he wishes to have more clearly explained, do my best to comply.

XQ141. You have, after long exploration of the patent and the prior state of the art, pointed out that the reproducer is described in the patent as being mounted so that it may be *free* to move in any direction. And you concluded from this that this means that it be free also to move in any direction to any extent. Now supposing this to be correct, a supposition which is here only made for the sake of simplifying the question, how, and in what manner does it appear from the patent that in the operation of the machine the style would ever be called upon to follow its freedom of movement laterally to a greater extent than one-half the width of a record groove. This is the question which I have now in substance repeatedly asked. If you can, please make answer thereto? 399

400 A. The patent very clearly describes the record tablet F as a removable one, the tablet being secured upon the metal disk E by means of the washer 3 and screw 2. Now when this tablet has a record formed thereon, and the same is removed from the machine and placed on another similar machine or replaced upon the original machine, it would be impossible to so place it that it would occupy the identical relation to the reproducer that it did to the recorder when the record was being formed: Moreover, if a dozen removable records were placed one after another on the machine to be reproduced by the reproducer, it would
401 be practically impossible to place any two of them in exactly similar relations with the reproducing style, that is, so that the record groove at any single point would be exactly the same distance from the axis of rotation, for example; furthermore, experience has proven that records will warp more or less after they are formed, and this deformation of the tablet would also have a tendency to vary the relations of the reproducing style and the same sound groove at different points along the groove. Now the patent clearly contemplates and describes a removable record; the machine and the description thereof are due to gentlemen of high scientific attainments who were thoroughly familiar with
402 the art to which the patent appertains, and it is fair to presume that when they introduced into their machine a removable record they recognized the necessity for providing for all the various requirements resulting from the employment of such a record. The variations which I have mentioned as being due to the presence of interchangeable records are in and of themselves infinitely greater than the mere one-half width of a record groove, and any producing style which would be guided by and follow a record groove under such conditions must of necessity in the operation of the machine have a lateral movement far exceeding the

width of the record groove. From the fact therefore that it appears in the patent that the employment of removable records is contemplated in the operation of the machine, and from the further fact that to successfully reproduce from removable records it is necessary that the reproducing style should have lateral movement greatly exceeding the width of the record groove, if it is to follow and be guided thereby as stated in the patent, I regard the patent as making it very clearly appear that in the operation of the machine the style would be called upon to follow its freedom of lateral movement to an extent greatly exceeding the one-half width of the record groove. 403

Adjourned to Friday, July 28th, 1899, at 10.30. 404

Washington, D. C.,
July 28th, 1899, 10.30 a. m.

Met pursuant to adjournment.

Present: Parties as before.

Mr. Lyons continues cross-examination of Mr. Cameron.

XQ142. In your last answer (answer to XQ141) you say, among other things, in effect that the lateral movement of the style that is required for making up for the variations introduced by interchangeable records is "infinitely greater" than one-half the width of a record groove. I suppose you do not mean to be taken literally. Will you please therefore give an idea how much greater than half the width of a record groove that lateral movement would have to be owing to the use of interchangeable records? 405

A. I stated in my answer to XQ141 that any reproducing style which would be guided by and follow the record groove under the conditions incident to interchangeable records must have a lateral movement far exceeding the width of the record

ting therewith were constructed exactly as shown 409
in the patent, that there would be necessity for a
lateral movement considerably exceeding that of
the mere width of the record groove in order that
the reproducer style might follow and be guided
by the record groove in interchangeable records.
Furthermore, the recording style of a recorder
does not always move in a perfectly true spiral,
but is liable to have considerable lateral vibration.
This would not only introduce variations in a
single record, but in interchangeable records the
variations would of necessity differ greatly, and
would occur at different parts of the record groove.
I am enabled therefore, from an inspection of the 410
drawings when read in the light of the description
of the patent, to state that with interchangeable
records in a machine constructed just as described
in the patent, the lateral movements of the style
must of necessity greatly exceed the width of the
record groove if the reproducer is to be "free to
follow the record" and be guided thereby.

XQ144. Suppose the record tablet having been
removed from the machine, is again placed there-
on in such fashion that a diametrically opposite
point of the tablet comes under the reproducing
style. Would not, under such conditions, the
record groove be just opposite the reproducing 411
style so that the latter, coming down upon the
record tablet by gravity and being free to move
laterally to the extent of one-half of the width of
the record groove, be snugly carried down to the
bottom of the groove?

A. It would not. With the screw 5 constructed
as shown in the patent, having some sixteen or
thereabout threads to the inch, the record grooves
would be spaced some distance apart upon the face
of the tablet, the spirals advancing in one complete
turn of the tablet a distance equal to the pitch of
the screw 5. If now the record tablet were placed
upon the machine as your question suggests, that

- 412 is, in a diametrically reversed position, it would be equal to having given it a one-half turn relative to the supporting plate E, and the spiral on the side of the axis adjoining the reproducer would have advanced one-half the pitch of the spiral, so that the reproducer, if brought upon the tablet, would be liable not to strike the record groove, but to strike the land or flat surface of the tablet between the spirals of the groove, and in order that the reproducer under such circumstances might find its proper place in the spiral groove it would be necessary for the reproducing style to be moved laterally to one side or the other. Having
413 been thus moved until the point of the style was placed in the record groove it would then adjust itself into operative relation with the groove through the yielding action of a spring or weight.

XQ145. Supposing the condition that we have just described to exist, then how would the style be moved laterally so as to come just opposite the groove? It would not do so automatically I suppose; it will have to be moved by hand. Is this what you mean?

- A. It might be moved by hand, or it might be allowed to rest upon the tablet at such point as might happen and upon revolving the tablet the spiral would advance so as to bring the groove
414 under the reproducing style.

XQ146. Now since the patent contemplates that the style adjust itself *automatically* to the record groove, it is clear, is it not, that the last procedure which you described may be followed; that is to say, the tablet would be allowed to revolve until it brings the record groove about opposite to the point of the style, and that then the latter would perform its automatic adjustment which then only requires a lateral movement of one-half the width of a record groove. Have I thus correctly described what would happen if the style is permitted to adjust itself *automatically*, instead of being adjusted by hand?

A. If the tablet is allowed to revolve until it brings the record groove about opposite the point of the style, the style would undoubtedly adjust itself automatically upon the record. 415

XQ147. The patent nowhere speaks of adjusting the style to the record by hand. Am I correct?

A. I believe it does not.

XQ148. The patent contemplates no other adjustment of the style to the record groove than the automatic adjustment. Is this correct?

A. The reproducer is shown in the patent as mounted upon a universal joint, and by reason of this free mounting may of course at any time be lifted by hand from the record and replaced thereon. In so doing there is nothing to limit the action of the operator in placing the reproducing style to one side or to the other as he may desire. Such operation is clearly within the possibilities of the construction described by the patent and may therefore, I think, be reasonably taken as within the contemplation of the patent. 416

XQ149. In your answer to XQ135, you pointed out that in the old Edison tinfoil phonograph the reproducing head was rigidly clamped and the style had to be adjusted to the record by hand. You then pointed out that Messrs. Bell and Tainter improved upon this construction and procedure by mounting the reproducer upon a universal joint by reason of which the style would adjust itself automatically to the record. If the statements you there made were correct, and I believe they are, then it would seem that the Bell and Tainter patent which is here in review not only does not contemplate hand adjustment of the style, but actually and purposely and ingeniously provides means for avoiding hand adjustment. If I am mistaken in this my understanding of what you have said in answer to XQ135, please correct me? 417

418 A. What I said in answer to XQ135 was that,
"this universal joint was useful (1) in enabling the
style to be adjusted in position upon the record,
and (2) it gave the style during the operations of
the machine a free lateral movement which the
Edison reproducing style did not possess." Your
question ignores the fact that there are two kinds
of adjustment for the reproducing style. A
record of any considerable extent covers a material
portion of the surface of the tablet, and it may be
desired to adjust the reproducer to any particular
portion of the record. Having brought it to such
419 portion of the record as may be found desirable,
it is then necessary to adjust the reproducing style
upon the engraved undulations constituting the
sound-record, and this latter adjustment, viz., that
which brings the rubbing point of the reproducing
style into actual operative relation with the sound
groove is one of great delicacy and is the adjust-
ment which is referred to in lines 62 to 67 of page
4, which states that if the reproducer K be allowed
to rest against the record the style will of itself gra-
vitate to the bottom of the groove. Now it by no
means follows, because the patent describes a means
whereby the style may automatically adjust it-
self into operative relation with the undulations
of the record, if the reproducer style be allowed
420 to rest upon the engraved line, that the patent
does not contemplate any other form of adjust-
ment, or that because it describes an automatic ad-
justment that therefore adjustment by hand can-
not be resorted to and is not contemplated. As a
matter of fact, in the daily operation of all ma-
chines made in substantial accordance with the
principles of the patents in suit, the coarser ad-
justments of the reproducer are made by hand after
which the style automatically adjusts itself into
operative relation with the undulations represent-
ing the sound waves.

XQ150. Now under the conditions which you have stated in your answer to XQ144, with the screw 5 shown in Fig. 1. having, as you say, sixteen threads to the inch, the hand adjustment of which you have spoken, if resorted to, under the conditions which you have described, would amount to a little less than one-thirty-second of an inch. This, I suppose, is mathematically correct. If not, please say so? 421

A. I do not wish to be understood as stating that the threads on the screw 5 are just sixteen to the inch, and I think my answer to XQ144 would indicate that I merely meant to mention sixteen threads to the inch as an approximation. The drawings in the patent are not, so far as I know, made exactly to the scale of the complete and operative machine, but as shown in the photolithographic copies of the patent there is approximately sixteen turns to the inch. However, the limit of the hand adjustment, whether the threads were sixteen or more or less to the inch, would by no means be as small as the one thirty-second of an inch. The reproducer may be readily adjusted by hand entirely across the portion of the record disk occupied by the spiral grooves; that is, from a point near the center of the disk to a point somewhat near its outer edge. For example, if it be desired to start the reproducer at the middle of the record it might be adjusted to such middle portion, or it might be set back several turns of the spiral, or forward several turns of the spiral, all of which adjustment could readily be made by hand, which being done, and the reproducer point or style being allowed to rest against the engraved line, the style would then gravitate to the bottom of the groove, thereby securing the automatic adjustment of the style point into operative relation with the undulations constituting the sound record. 422 423

424 XQ151. Now Mr. Cameron, will you please state from where you take all this; that is to say, from where do you take the fact that there is a hand adjustment provided by the patent or contemplated by the patent; and from where do you take the fact that such hand adjustment is provided and contemplated to have a sweep across the whole record and that it is or may be resorted to for the purpose of starting the reproduction at one or another point on the record?

425 A. That the reproducer is capable of such hand adjustment I learn by reading the description of the patent in connection with the drawings illustrating the same and at the same time exercising ordinary mechanical common sense. The patent says that the reproducer is mounted on a universal joint and that it is free. A reproducer thus mounted on a universal joint unless some means were shown or described which would clearly limit the swing of the reproducer about the joint, would necessarily be such as to be adjusted from side to side. I have repeatedly stated that I find nothing in the patent nor in the necessary operation of the machine that would place any limit upon the lateral movement of the reproducer about the universal joint within the limits of the space covered by the spirals on the record tablet,
426 and inasmuch as the patent states that the reproducer is universally mounted and does not state any limitation within the space occupied by the record, I repeat that it requires but the exercise of the most ordinary mechanical sense to recognize the fact that the reproducer is capable of a sweep entirely across that portion of the record lying between the axis and the periphery of the disk. I learn from actual experience with machines made in accordance with the principles of the patents in suit that it is frequently desirable to adjust the reproducer by hand so as to have it commence operation at any desired point on the record.

For instance, when correspondence has been dictated to a machine and the same is being transferred by a typewriter it is frequently desirable to have a sentence which has been reproduced repeated a second time. In order to do this the operator moves the reproducer back a slight distance, throwing the reproducing style again in contact with the record, and the point of the style automatically adjusting itself into operative relation with the undulations of the record groove, the machine proceeds as before. As I have heretofore stated, I conceive that any operation of the machine that is rendered possible by the construction shown and described in the patent may be fairly considered as within the contemplation of the patent, and since this lateral movement of the reproducer is clearly within the construction described and shown in the patent, I think it is fair to say that it falls within the contemplation of the patent. Of course, I do not fail to realize that the ideal position of the recording style is stated to be preferably immediately opposite the pinion G which operates the disk E, in order that the said pinion may operate as a support for the disk E, against the operation of the cutting style. But while it may be preferable, as stated in the patent, to have the point of the style immediately opposite the friction wheel G when *recording*, the same advantage would not be secured when operating the reproducer. Furthermore, it is apparent that if the reproducer rest upon the record at a point between the axis of the record and the wheel G, that the same would be amply supported against the very slight weight of the reproducer, and even if it rested on that portion of the record outside of and beyond the friction wheel G where there might possibly be some yielding action of the record, it is one of the exceedingly beautiful functions of the reproducer, due to its universal mounting, that

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430 it would readily follow such slight yielding as might be found in the record, and maintain the rubbing style of the reproducer in perfect operative relation with the undulations of the record, notwithstanding the irregularities in the surface of the record which might be the result of the yielding action thereof.

431 XQ152. In order that there be no misunderstanding created by what you have stated in your last answer, will you please make it clear that the lateral adjustment of the reproducer across the tablet in the commercial machine which you say embodies the principles of operation of the patent here under consideration, is not made with the universal joint, but is made by unlocking the feed nut and sliding the reproducer head to whichever point it is desired?

A. That is quite true. I have already explained I think, in my examination in chief, that in the commercial machines the arm upon which the reproducer head is mounted is, for the sake of compactness, very much shortened, and that instead of moving the record rectilinearly past the point of the style, as is shown in the patent, the reproducer is moved in a right line along the record tablet.

432 XQ153. The commercial machines with which you are familiar and of which you say that they are made in accordance with the patents in suit, the universal mounting of the reproducer will only permit the style to move laterally three one-hundredths of an inch in one direction, and just as much in the other direction. We have this information from your own testimony. Consequently, it would be impossible to adjust the stylus by reason of its *free* universal, mounting right across the record tablet, but it would only be possible to move it three one-hundredths of an inch. Is this correct?

A. The ordinary commercial graphophone, made in accordance with the principles of the patents in suit, has a reproducer mounted on a universal joint so that the reproducer may move freely in any direction. In the machine thus constructed, however, there are means employed in connection with the universal mounting whereby the lateral movement of the reproducer has a certain limit placed thereon, such limit, however, permitting the reproducer to have an extreme lateral movement in the cases which I have observed, of about six one-hundredths of an inch, and it is possible to move the reproducer, therefore, in a lateral direction the extent of six one-hundredths of an inch. I do not understand, however, that the fact that the manufacturer in making the commercial machine sees fit to introduce stops or conditions which act as a limitation to the lateral movement of the reproducer, by any means indicates that therefore the patentees in their patent designed such limitation as a necessity of their construction. On the contrary, in the absence of any stops or other limitations to the lateral movement of the reproducer entirely across the spirals of the record groove as defined by the patent, I repeat that a construction wherein the reproducer is mounted on a universal joint which gives unrestricted lateral movement across the spirals of the record would, in my opinion, be clearly within the contemplation of the patent.

XQ154. The fact, however, that the builders of such a commercial machine limit the freedom of lateral movement of the reproducer head about the universal joint to three one-hundredths of an inch in either direction, would indicate, would it not, that a greater lateral movement would serve no useful purpose?

A. Certainly not. It simply indicates that in the particular type of machine which the manufacturer is making a greater lateral movement is

436 not necessary. For many reasons it rarely happens that the commercial form of a machine is identical with the Patent Office drawings. Many changes are made in minor details, many parts of the machine are used while other parts are omitted. It frequently happens that a particular way of accomplishing a function as shown in the Patent Office drawing is superseded by another way adopted in the commercial machine. Especially is this true when the patent lies at the foundation of the commercial art, as is the case with patent No. 341,214 in suit. I have already explained that in order to construct a compact machine and
437 one operating with a cylindrical rather than a disk form of record, it is found desirable to greatly shorten the arm between the reproducer head and the universal joint of the mounting. I have also explained that instead of moving the record in a right line past the reproducer, the reproducer is advanced in a right line past the record. All of these contribute to the compactness and simplicity of construction of the machine, but because this is so it by no manner of means follows that the specific construction disclosed by the patent "would serve no useful purpose." I cannot therefore consent to the proposition that since the builders of the commercial machine do not permit the reproducer
438 to have unlimited lateral movement about its universal joint, this would indicate that a greater lateral movement would serve no useful purpose. It simply indicates the preference, for reasons best known to themselves, of the manufacturers for the particular construction adopted.

XQ155. This being the case, we shall have to rivet our attention to the machine shown and described in the patent. Now, with respect to this machine you say that there is nothing shown in the patent that would act as a stop or limit to the lateral movement of the reproducer head about the universal joint between the outermost and inner-

most record groove. Do I thus correctly understand you? 439

A. That is substantially correct, yes, sir.

XQ156. And how much space would you give to a record made upon this machine, not merely for the fun of making it, but for some useful or commercial purpose?

A. That would depend entirely upon the size and general proportions of the machine, as well as upon the particular record which it would be found desirable to make. It might vary from a single spiral line around the record disk, to a band of spiral grooves one, two or more inches across.

XQ157. You have never seen a machine constructed as illustrated and described in patent No. 341,214, and from your testimony it appears that you are unwilling to assign any particular length or thickness to the rubber tube which here forms the universal joint. Now a rubber tube of what ever length or thickness limits in some fashion the extent to which it can be bent by such force as are active in this machine. Under such circumstances, how can you say that the particular universal joint shown and described in the patent has no such limits to its free lateral play as is found in the commercial machine? 440

A. The patent describes as one of the particular features of which the invention consists, a reproducer so loosely mounted that it can readily be guided by the record and defines a universal joint as the means by which this loose mounting is secured. It then specifies a section of soft rubber tube as constituting the universal joint. It necessarily follows from this statement, and the further statement that the flexibility of the tube is such as to leave the style free to follow the record, that the rubber tube is of such length and of such flexibility as to give the reproducer such movement as would be obtained by the ordinary forms of universal joint. Undoubtedly, if the rubber tube 441

442 is sharply bent to one side there is a limit to the extent to which it will readily flex, and it is equally true, as suggested by the question, that the forces which are active in the machine in the patent in suit, that is, the guiding action of the sound groove, has a limit beyond which it would be sufficient to bend or flex the tube. But clearly this will depend greatly upon the length, thickness and general flexibility of the tube itself, and in a tube which is capable of being readily bent throughout an extent of more than 180 degrees, the influences of the record groove in guiding the reproducer would undoubtedly be sufficiently great to bend the tube so as to allow the reproducer a much greater play than the very few degrees that would be necessary to carry it entirely across the band of the spiral grooves constituting the record.

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XQ158. And is it your idea that a section of rubber tube as short as shown in the drawing of the patent could be bent to an angle of 180°?

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A. It is impossible to say what the length of the rubber tubing shown in the patent is; but as I have stated, the patent describes the rubber tubing as being such as to constitute in effect a universal joint, and a section of rubber tubing sufficient to do this could readily be bent to the extent of 90° on either side of a medial position, and would therefore be capable, when bent to its full extent on either side, of being flexed through an arc of 180° or more.

XQ159. Now Mr. Cameron, although not called upon to do so, you were quite willing at one time to estimate from the patent drawing the pitch of the screw 5. Why are you now unwilling to estimate similarly the length of the section of rubber tube which constitutes the universal joint?

A. If counsel desires it I can do more than estimate the length of the section of rubber tubing as the same is shown in the Patent No. 341,214 in suit, that is, as it appears in the reduced photo-

lithographic drawings of the Patent Office copy, but I have previously stated that in the absence of a scale to which the drawings are made, it would be absolutely impossible to state with any accuracy just what the length or thickness of the section of rubber tubing 32 might be. I have also pointed out that the patent itself states it is not the intention of the patent to limit the invention to the precise dimensions shown, and in view of this fact and the further fact that the section of rubber tubing is described as constituting a universal joint, I repeat what I have previously stated, that I understand it to be of such length and of such dimensions as is necessary to enable it to perform the functions of a universal joint.

XQ160. Supposing for the moment, that the rubber tubing furnishes a universal joint of the character you ascribe to it; that is to say, that it will allow the reproducer to freely move laterally across the record from the outermost to the innermost record groove. Under this assumption, will you please state what would be the use of the screw 5, the nut 6, and of the gear wheels 1 and 4?

A. With a record cut in wax or wax-like composition, it is desirable to have the reproducer track smoothly and evenly in the groove without any drag upon one side of the record groove in excess of that upon the other. It follows from this that the preferable position of the reproducer is such as shown in Fig. 1 and 2 of the drawings in suit, that is, such that the revolutions of the disk will carry the record groove under the point of the style in very nearly a right line. In order to secure this the most desirable position of the reproducer in relation to the record groove, it is necessary either that the record be carried past the reproducer in a rectilinear line, or that the reproducer be carried past the record. In the patent in suit the record is moved relative to the repro-

448 ducer, and in order to accomplish this the shaft of
the disk supporting the record is mounted upon a
slide carrying the screw 5, and the shaft of the
record disk and of the screw are geared together
by the miter gear 1 and 4. The screw passes
through a stationary nut 6 attached to the frame-
work of the machine. The revolutions of the
record disk cause corresponding revolutions of the
screw 5, thereby causing it to travel through its
nut 6 and draw with it the slide C carrying the
disk. By this means the record is compelled to
travel in a right line under the point of the style
as well as to revolve under the style. I have al-
449 ready explained that in the commercial forms of
the machine, the record is revolved, but is with-
out rectilinear motion, the reproducer being
mounted on a screw which carries it in a right line
across the record groove, thereby accomplishing
the same result as the screw of the patent.

Adjourned to Saturday, July 29th, 1899, at 10.30
a. m.

Washington, D. C., July 29th, 1899,
10.30 a. m.

Met pursuant to adjournment.

Present: Parties as before.

450 Mr. Lyons continues cross-examination of Mr.
Cameron.

XQ161. In the apparatus shown in Figs. 1,
2 and 3 of Patent No. 341,214, the tablet is
mounted upon a horizontal axis so that the face of
the tablet itself is in a vertical plane. Is this cor-
rect?

A. It is.

XQ162. And in the modified apparatus shown in
Figs. 12, 13 and 14, the face of the tablet is also
in a vertical plane?

A. It is.

XQ163. The section of rubber tubing 32 which is designed to act as a universal joint must hold the reproducer approximately vertically in a slightly forwardly inclined position. Is this also correct? 451

A. The stem supporting the reproducer is very materially inclined from the vertical, so much so that if the record were removed the reproducer would fall; that is, the reproducer is held against the face of the record by the action of gravity modified by the elasticity of the section of rubber tubing. It certainly would not be proper to state that the reproducer is held in a vertical position by the section of rubber tubing.

XQ164. But the tube must be rigid enough to normally support the weight of the reproducer head sufficiently to prevent it from toppling over to the right or left in the construction shown in Figs. 1, 2 and 3. Is this not so? 452

A. As shown in Figs. 1 and 2 the recorder is in position with the recording style resting against the face of the tablet, but it is in approximately the position that would be occupied by the reproducer in the act of reproducing. In this position the reproducer would be supported by the stem, a portion of which consists of the section of soft rubber tubing, and by the tablet. The tendency of the reproducer in this position is to fall forward towards the tablet, rather than to the one side or the other. Undoubtedly, however, the section of rubber tubing must have sufficient rigidity to perform its part of the work in supporting the reproducer. The reproducer, however, is so exceedingly light that a very soft and flexible tubing would be sufficient for this purpose. 453

XQ165. Now referring to the construction shown in Fig. 13, I there observe that the rubber tube section 32 supports the weight of the reproducer head K entirely, unaided by the tablet, because in the position shown in that drawing the reproducer style is not in engagement with the

454 tablet. In this case, therefore, the rubber tube section 34 must be sufficiently stiff to support the whole weight of the reproducer head. Is this not so?

A. In Fig. 13 which is a plan of the modification shown in Fig. 12, the reproducer K is shown thrown out of operation, the recorder H' being in active operation. If Fig. 13 were viewed as an upright sectional view, it might readily appear that the reproducer K was supported by the section of rubber tubing 32 above the tablet F, but inasmuch as it is a plan and not a vertical section, and inasmuch as the reproducer is shown withdrawn from
455 operative relation with the tablet, and is immediately over that portion of the frame marked B, I do not think that it can be authoritatively stated that the weight of the reproducer is supported solely by the section of soft rubber tubing 32. Apparently the reproducer is turned down so as to rest upon the frame B.

XQ166. You are then not willing to say that in the position shown in Fig. 13 the reproducer K is wholly supported by the section of rubber tubing 32, but you mean to indicate that the head rests upon the framework B of the machine?

A. Apparently the reproducer is turned down so as to rest upon the frame B of the machine, though
456 no statement to this effect is found in the specification.

XQ167. If what you say were true then, the reproducer could never press by gravity upon the record tablet. Is this not so?

A. I don't think that follows at all.

XQ168. Now let us be clear about this. You assume, I suppose, from what you have stated, that B represents in Fig. 13 a horizontal platform of the frame marked with the same letter of reference in Fig. 12; and you assume that the reproducer can swing in a vertical plane parallel to that of the record tablet, swing as a hinge in the ears

shown on the little plate 72. I suppose that this 457
must be your interpretation of this drawing if you
assume that the head of the reproducer is sup-
ported by the frame B. Now if this is the case,
and if, as we see in the drawing, neither the head
of the reproducer, nor the style is in contact with
the tablet, does it not follow from this that which-
ever way the head may be swung, it will always
swing in a plane parallel to the face of the tablet
and can therefore never be supported by the
tablet, and particularly can it never bear by
gravity upon the tablet. If I misrepresent the
conditions, please correct me?

A. The description contained in the patent of 458
the modified structure shown in Figures 12 and
13, is very meagre so far as that portion which
refers to the mounting of the reproducer K is con-
cerned. It states, lines 57 to 65, page 5 that:

"In this machine the reproducer K, instead
of being mounted on the same bracket as the
recorder when the latter has been removed,
is carried by a separate bracket, 72, the tube
33 being hinged thereto, so that the recorder
and reproducer remain, or may remain, always
attached to the machine, it only being necessary
to turn one or the other into position, as may
be required."

This clause contains all there is in the specifica- 459
tion relating to the particular modification of the
reproducer mounting shown in Fig. 13. It would
seem to indicate that the reproducer could be
turned into and out of operative relation with the
record. Further than that it does not go. It is
quite possible, although I do not undertake to
state that such is actually the case, that the repro-
ducer was intended to be advanced toward and
from the record by means of what appears to be a
slot and clamp screw connection between the
bracket 72 and the frame B. Furthermore, in view
of the fact that in this modification the tablet

460 swings upon the shaft 50 as a pivot, rather than travels in a right line, it is quite possible that in the act of reproducing the tablet and the reproducer would not occupy the same relative positions in which they are shown in Fig. 13. However all of this is left so vague and uncertain in the description and illustration so far as it refers to the action of the reproducer, that I would not undertake to state what the exact position of the parts when co-operating in the act of reproduction really is.

461 XQ169. You have heretofore said that this patent is exceptionally well drawn; and you are a solicitor of patents—an expert in patent causes, and an ex-assistant examiner in the United States Patent Office. You are therefore well qualified to read and interpret descriptions of mechanical devices. Particularly are you familiar with this patent since you have undertaken to testify with respect thereto.

In view of all this, will you be so kind as to state whether in the construction shown in Fig. 13 the reproducer head can be swung about its hinge in a vertical plane parallel to the face of the record, and if so, whether it can ever bear by gravity upon the record tablet, or its style by gravity upon the record?

462 A. That portion of the specification included between lines 57 to 65, page 5, would seem to indicate that both the recorder and the reproducer shown in Fig. 13 are intended to be turned into position to operate in connection with the record tablet. I would surmise from the outline of the drawings of Fig. 13 that the reproducer would swing in a plane substantially vertical in thus turning, if it turned as it would appear to do, about that portion of the part marked 32 which extends through the ears of the bracket 72. If the reproducer remained in the position shown in Fig. 13, that is, if the bracket

72 was not advanced any nearer the record tablet, the reproducer would be out of operative relation with the tablet, and I therefore presume that the bracket is to be advanced toward the tablet when the reproducer is thrown into operation. The reproducer might very readily be in such case held in operative relation with the undulations constituting the sound record by a spring which is the recognized equivalent of gravity. 465

XQ170. I take it that you mean your answer to convey the idea that the style can with this construction never bear by gravity upon the record, but must be made to bear upon it by the pressure of the spring. Do I thus correctly understand your answer? 464

A. Not at all. I did not say and did not mean to be understood as indicating that the reproducer of the construction shown in Fig. 13 could not by any possibility bear upon the record by gravity. The patent is silent upon this point, merely indicating that the reproducer and the recorder are separately mounted so that one may be turned into operation and the other out of operation without removing either from the machine. It is quite possible that the reproducer shown could be held in operative relation with the record by a spring which, as I have stated in my last answer, is the equivalent of gravity, and I should certainly hesitate to say that it could not be held in such position through the operation of gravity alone. 465

XQ171. Well, you had no difficulty in showing how the style may be held in operative relation to the record by the action of a spring, and you will therefore be so kind as to explain how it could be possible, in view of what is shown in the drawing (Fig. 13), that the style be brought and held in operative relation with the record by gravity?

A. I have not stated that this could be done. I have stated that I should hesitate to state that it could not be done, and pointed out that this is a

466 different statement from the assertion that the style can never bear with gravity upon the record.

XQ172. Can you point out a way to make the style bear with gravity upon the record in the construction shown in Fig. 13?

A. I do not off hand perceive any way in which this could be done without making some slight changes in the manner in which the parts are connected and arranged.

467 XQ173. Now as regards the spring which would establish and maintain the operative relation between the style and the record, can you point out in the drawing Fig. 13, any other spring that would perform this function than the section of rubber tubing 32?

A. There is no spring shown in Fig. 13 in connection with the reproducer except such as might be due to the rubber tube.

XQ174. But the rubber tube spring would be all sufficient, would it not, to maintain operative relation between the style and record if once the relation is established by sliding the bracket 72 forwardly a sufficient amount and then clamping it. Is this so?

A. The section of rubber tubing might be so proportioned as to furnish the necessary spring tension.

468 XQ175. Now, this being so, and no other spring being shown, is it not clear that this rubber tubing must be sufficiently stiff to support the weight of the reproducer head K without bending?

A. I do not think so.

XQ176. How could the rubber tubing act as a spring to maintain the style in operative relation with the record as a spring if it were not stiff enough to support the weight of the head without perceptibly bending?

A. If the reproducer were advanced in the direction of the tablet far enough so as to slightly flex the rubber tubing thereby placing it under tension

it could exert upon the reproducer sufficient 469
spring tension to hold it in operative relation
with the undulations even though the tubing
were not stiff enough to support the reproducer
without flexing.

Adjourned at request of counsel for defendants
to Wednesday, August 2d, 1899, at 10.30 a. m.

Wednesday, August 2d, 1899, 10.30 a. m.

Met pursuant to adjournment.

Present: Parties as before.

Adjourned to August 31st, 1899, at 10.30 a. m. 470
at request of counsel for defendants, defendants'
counsel agreeing to conduct the cross-examination
of Mr. Cameron continuously until completed begin-
ning on said date.

Washington, D. C.

Sept. 11th, 1899.

10:30 a. m.

Met pursuant to adjournment and subsequent
agreement of counsel.

Present—PHILIP MAURO, Esq., of counsel for 471
Complainant.

JOSEPH LYONS, Esq., of counsel for
Defendants.

Mr. Lyons continues cross-examination of Mr. Cam-
eron:

XQ177. Please consider the construction of ap-
paratus represented by Figs. 12 and 13 in the Bell
and Tainter Patent No. 341,214, in suit, and state
from your thorough knowledge of this patent the
position of the reproducer with reference to the
record tablet when the record is to be reproduced.
It would be of advantage if you could in your

472 answer abstain as much as possible from technicalities in order that a clear idea of your conception of the mode of reproducing by means of that apparatus may be obtained.

A. The patent contains a very limited statement in regard to the reproducer of Figs. 12 and 13 and its co-operation with the record in the act of reproducing. It states in lines 57 to 65, page 5, that:

473 "In this machine the reproducer K, instead of being mounted on the same bracket as the recorder when the latter has been removed, is carried by a separate bracket, 72, the tube 33 being hinged thereto, so that the recorder and reproducer remain, or may remain, always attached to the machine, it only being necessary to turn one or the other into position, as may be required."

I understand from this statement that the reproducer is capable of being turned into and out of operative relation with the record, but am unable to state with positiveness just how this is to be done. Apparently it is to be turned in the clips or ears attached to the plate marked 72, and apparently this plate is adjustable towards and from the record, but in the absence of any clear statement in the specification that such is the fact, I should
474 hesitate to make this as a positive statement.

The only feature that is clearly brought out in regard to the action of the reproducer shown in Fig. 13, is that it is capable of being turned into and out of operative relation with the record without being removed from the machine, and that the same is true of the recorder, so that one can be turned out of operation as the other is turned into operation and *vice versa*.

XQ178. Is your last answer to be construed as meaning that you would not know how to reproduce a record by means of the machine constructed as shown in and described with reference to Figs. 12 and 13?

A. My answer is to be construed as meaning that I will not undertake to state positively the action of a part which is not clearly described in the specification and is only incidentally referred to in the passage quoted in my answer.

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XQ179. From the drawing and from the description, it is clear, is it not, that the reproducer of the machine, Figs. 12 and 13 must be *turned* into position for reproducing; and it is also clear, is it not, that the only means for *turning* the reproducer is the *hinge* about which the tube 33 may turn?

A. I think not. The bracket plate 72 might, so far as appears from anything shown in the drawing, be turned about what appears to be a set screw passing through a slot in said plate, and by so turning the style of the reproducer might be brought nearer to or farther from the face of the record. It is quite possible, however, that the turning action whereby the reproducer is brought into operative position would be about the tube as the same turns in the ears of the bracket plate 72, though in this case it would be necessary not only to turn the reproducer into the desired position, but also to by some means advance the bracket plate 72 supporting the same nearer to the face of the record tablet than it appears in the illustration of Fig. 13. Apparently the slot shown in that bracket plate 72 and in connection with what appears to be a set screw are provided for this purpose; but as I have heretofore stated, the description and illustration are such as to make it impossible for me to state exactly how the reproducer will have to be operated in order to bring it into proper relation with the record.

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XQ180. You claim particular familiarity with this patent and you also claim considerable knowledge of sound recording and reproducing machines generally; and you have now given your understanding of the construction of the machine rep-

478 resented in Figs. 12 and 13. Will you now please state how you would proceed if you were called upon to reproduce a record by means of this machine?

A. I have already stated that in reply to your previous question with as much accuracy as I can do with the description and illustration afforded by the patent.

479 XQ181. You misunderstood my last question. From the drawing and from the description of the patent you have deduced certain possibilities of adjustment of the reproducer with reference to the record tablet for the purpose of reproducing. Now, will you please make use of these possibilities and state how you as an expert would manipulate this machine in the attempt of reproducing sounds recorded upon a tablet?

480 A. As I have heretofore intimated that it is impossible to obtain from the patent any positive idea as to the manner in which the reproducer is to be moved in order to bring it into operative relation with the record, it would manifestly be impossible for me to state with accuracy just how I would proceed to manipulate the reproducer in order to reproduce from a record. For this reason it would be impossible for me to answer your question and state how I would manipulate the machine in an attempt to reproduce sounds recorded upon the tablet.

XQ182. You are experienced in reading patent drawings and you are experienced in reading and interpreting patent specifications. It may therefore be said that the machine represented by Figs. 12 and 13 of the patent here under consideration, is now before you. You are also an expert with respect to sound recording and reproducing machines, and the question now is whether you would undertake to use the machine in question for reproducing sounds?

A. With a reproducer constructed and mounted precisely as shown in Fig. 13 I cannot say that I would. 481

XQ183. You have heretofore called attention to those parts of the specification of Patent No. 341,214, which indicate to your mind that the inventors contemplated the use of other records than such as are represented by elevations and depressions at the bottom of the groove, and others than such as are represented by a groove with sloping walls. You particularly said that the inventors must have been acquainted with a record represented by an undulating groove of even depth.

I now call your attention to the patent of Sumner Tainter No. 341,287, dated May 4th, 1886, and I will ask you whether you do not there find described a record consisting of elevations and depressions formed upon spirally formed ridges; and whether you will credit Messrs. Bell and Tainter with knowledge of that Tainter record? 482

A. The record referred to in your question is doubtless that illustrated in Figs. 3 and 13 of the Tainter patent No. 341,287. Of this record the patent states, in lines 92, page 1, *et seq.*, that:

"Fig. 13 is an illustration of an iron record in perspective and section, the point of the reproducing needle being shown in position. 483

In preparing the iron record according to the best mode to me known, the record is first cut in wax or a waxy composition as described in the before mentioned application; but the cutting style, which is attached to a vibratory diaphragm, has preferably a flat or chisel like point, so that the recording tablet is engraved with a spiral groove of trapezoidal cross-section, the elevations and depressions at the bottom of the groove representing the forms of the sound-waves which act successively upon the diaphragm of the recording instrument."

The "before mentioned application" referred to in this paragraph is that of Bell and Tainter filed

484 June 27th, 1885, under serial number 170,044 which materialized into the Bell and Tainter Patent No. 341,214 in suit. The date of the application of the Tainter Patent No. 341,287 was some two months later than that of the Bell and Tainter Patent in suit No. 341,214, and I am unable to state whether Messrs. Bell and Tainter at the time of making the application of the patent in suit were or were not familiar with the form of record described in the patent to Tainter No. 341,287.

485 XQ184. Turning now again to the Bell and Tainter Patent in suit, No. 341,214, will you please state whether you ever saw a record tablet prepared with the materials described in the said patent?

A. I do not know that I have ever seen a record tablet prepared of bees wax and paraffine in the proportions specified by the patent.

XQ185. Have you any idea how the tablet prepared in accordance with the patent would compare in hardness with the modern phonograph record tablet?

A. The paraffine and bees wax tablet described in the patent in suit would in my opinion be somewhat softer than the modern wax-like tablet of commerce.

486 XQ186. You have heretofore stated in effect that with the apparatus represented by Figs. 1, 2 and 3 of Patent No. 341,214, the utility of the feed-screw 5 and connected gearing is found in the fact that it positively propels the record tablet in a straight line, in addition to its rotary movement, and thereby prevents the style from bearing on one side of the record groove more forcibly than on the other. Is it not a fact that if this gearing were put out of action somehow or other, and if the rubber universal joint had as wide a sweep as you say that it might have, the style would constantly bear on one side of the record groove?

A. The tendency would be for the style to drag against the rear side of the groove, that is, the side opposite to the direction in which the tablet is moving. 487

XQ187. And in that case the style would be propelled across the record by the record itself? Is this correct?

A. I think it is.

XQ188. And in order to avoid this being done the screw and connected gearing were provided? Is this correct?

A. It is not. The screw and nut were provided for the purpose of positively moving the record in a right line past the style of the reproducer. The inventors, however, recognized that there might be and probably would be at times a failure on the part of the screw to advance the record with regularity and precision and they therefore pointed out that one of the functions of the universally mounted reproducer was to enable the style to follow and adjust itself to the record even when the normal and intended operation of the screw did not operate to advance the record with that regularity and precision which is necessary for the correct reproduction of sound. It would be a complete inversion of the ideas of the inventor to state that the screw and connected gearing were provided in order to avoid the feeding of the reproducing style by the record groove. 488

XQ189. Please refer to your answer to XQ160. It appears to me that you there said that the feature of utility of the screw and connected gearing is found in the fact that it will prevent any drag of the stylus upon one side of the record groove in excess of that upon the other. From your last answer, if I understand it correctly, it would seem that you now believe that the inventors had no such idea; that they would tolerate a drag upon one side of the record groove. Please reconcile these two answers and at the same time state, if 489

490 you can, what could possibly be the use of the feed screw and its connected gearing if the inventors had recognized the possibility of propelling the style across the record by the record?

A. There is in my answers to XQ160 and XQ188 nothing requiring any reconciliation whatever, nor is there any contradiction except as the same appears to have been studiously sought for by the ingenuity of counsel. I stated in my answer to XQ160 that the *preferable* position of the reproducer was such that the revolutions of the disk will carry the record groove under the point of the style in very nearly a right line, and that in order
491 to secure this the most desirable position of the reproducer in relation to the record groove it is necessary either that the record be carried past the reproducer, or the reproducer past the record.

In the patent in suit the screw 5, shown in Fig. 1, operates in conjunction with the Nut 6 to advance the record in a right line past the groove. If this is perfectly accomplished the result will be that the reproducer will track smoothly and evenly in the groove without any drag upon one side of the record groove in excess of that upon the other. If the mechanism fails to act with accuracy and precision in thus advancing the record groove past the point of the reproducing style, the style would,
492 if rigidly mounted, be thrown out of the groove, therefore out of adjustment with the record, and be wholly unable to follow the record, thereby making reproduction impossible. The inventors, however, mounted their reproducer, not rigidly as had theretofore been done in the art, but loosely upon a universal joint and pointed out that one of the functions of this universal joint was to permit the style to adjust itself to and follow the record even in case of any disarrangement of the machine.

The reason why, in my opinion, XQ188 is not correct is because it confuses cause and effect. The nut and screw 6 and 5, Fig. 1, were designed

not to prevent the drag of the style upon the record groove, but for the purpose of advancing the record past the style. It is true that one of the incidental effects, if the parts operate with precision, is to advance the style over the record groove without any drag. It is also true, however, that the inventors introduced for the first time into the art of recording and reproducing sound, a feature, viz., a loosely mounted reproducer, which would permit the reproducing style to follow the record when the nut and screw failed to function perfectly by reason of any derangement of the machine or otherwise, and they pointed out the fact that by reason of this construction the reproducer at such times would be free to follow the record. The feature of prominent importance, however, in the construction of the nut and screw feeding device, is that it is designed to feed the undulations of the record groove past the point of the style in the ideal position for correct reproduction.

XQ190. In your answer to XQ160 you said:

"With a record cut in wax or wax-like composition, it is desirable to have the reproducer track smoothly and evenly in the groove without any drag upon one side of the record groove in excess of that upon the other. It follows from this that the preferable position of the reproducer is such as shown in Figs. 1 and 2 of the drawings in suit, that is such that the revolutions of the disk will carry the record groove under the point of the style in very nearly a right line."

You then continue to point out that this result is secured by the feed screw and nut and connected gearing. Am I then mistaken in reading your answer to mean that the feed screw, nut and connected gearing were designed for the purpose of preventing the drag of the style upon one side of the groove in excess of the other?

A. The feed screw, nut and connected gearing were designed for the purpose of moving the rec-

- 496 ord groove under the reproducing style in the best position for securing a correct reproduction of the sound. One of the incidental effects of the operation of said feed screw, nut and connected gearing when the same operates with accuracy and precision, is to move the record under the reproducing style without any drag upon one side of the groove in excess of the other, but as I have before repeatedly stated, to say that the feed screw, nut and connected gearing were designed for this purpose is to state one of the incidental effects as if it were the prime or moving cause or object for the whole construction. If you have read my answer to XQ160 to mean that the prevention of the drag was the main object of the construction rather than a merely incidental effect, then you are mistaken in your reading of the answer.

497 XQ191. Good. If the main object of the screw, nut and connected gearing is to move the tablet under the reproducing style in a right line past the stylus, the inventors could not have contemplated of moving the style across the tablet. Could they?

- 498 A. Certainly they could. They pointed out, as I have stated over and over again, that one of the functions of the loosely mounted reproducer was to enable it to follow the record when through any disarrangement of the machine the reproducing style would be thrown out of touch with the record groove at precisely the proper point for proper reproduction. In my opinion the universally mounted reproducer would enable it to follow the record with the reproducing style in such relation with the record groove as to enable it to reproduce the recorded sounds even if the co-acting nut and screw failed to advance the tablet past the style. The inventors themselves clearly point this out when they say that

"The movement parallel with the face of the tablet would, however, by itself allow the

style to follow and adjust itself to the record
to a useful extent." 499

Q192. Now, right here, please refer to the particular portion of the patent from which you have just quoted, and state by what construction the "movement parallel to the face of the tablet" is made possible?

A. After speaking of the liability of disarrangement which may occur in some parts of the machine the patent states, lines 74, page 4. *et seq.*, that

"Difficulties on these accounts are avoided by the loose or flexible mounting of the reproducer, the style automatically adjusting itself to the proper place on the record. It will be seen that the reproducer is mounted on a universal joint, so that it can move in *any* direction. The movement parallel to the face of the tablet would, however, by itself allow the style to follow and adjust itself to the record to a useful extent." 500

(Metallic mine).

Movement due to a universal joint would enable the reproducer to move as stated in the quotation just made, in any direction, but the specification points out that if it only had movement parallel with the face of the tablet that such movement would by itself allow the style to follow the record. 501

I therefore regard the loosely mounted or universally joint reproducer as the construction by which the movement parallel to the face of the tablet is made possible.

Q193. And is this true; that is to say, is it true that if the reproducer had only freedom of moving to any degree parallel to the face of the record, it could adjust itself automatically to a record?

A. I think it is, though I should not regard a reproducer which was rigid so far as vertical move-

502 ment was concerned and free only to move parallel with the face of the tablet, as being an ideal construction. The preferable form would certainly be the loosely mounted reproducer whereby it is enabled to float as it were upon the surface of the record responding as a whole to the grosser irregularities of the tablet and always maintaining the reproducing style in position to be accurately operated upon by undulations of the record groove.

Adjourned to Tuesday, September 12th, 1899, at 10:30.

503

Tuesday, September 12th, 1899.

10:30 a. m.

Met pursuant to adjournment.

Present: Parties as before.

Mr. Lyons continues cross-examination of Mr. Cameron:

504 XQ194. Suppose you had a reproducer that is rigid and unyielding as far as vertical movement is concerned, but is free to move laterally, no matter to what extent; and suppose that there were such irregularities in the machine as a whole as to cause the tablet to wobble while it is being rotated. How would the movement parallel with the face of the tablet allow the style to adjust itself to the record to any extent?

A. Any wobbling of the record tablet would tend to disturb the precision with which the record groove would advance under the reproducing style. Not only would this disturbance occur with relation to the vertical adjustment of the style to the record, but also with relation to the lateral adjustment thereof, and any capability of lateral movement which the style might possess would

enable the latter to adjust itself to the groove notwithstanding the irregular movements of the same caused by the disarrangement of the machine. If however, the "wabbling" of the tablet, assuming the same to be in the form of a disk, were such as to introduce any very great disturbance parallel with the surface of the disk, a reproducer which was rigidly mounted so as to be prohibited from having a movement normal to the plane of the disk would undoubtedly fail to properly reproduce the recorded sound, would mar the record to a considerable extent and in the case of any very material disturbance of the plane of the tablet might even stop the machine. The ability of the Bell and Tainter floating or gravity reproducer to automatically adjust itself at all times into proper operative relation with the record groove notwithstanding any irregularities of the tablet due to "wabbling" or other matters causing the same to depart from a true surface is one of its most meritorious features. And this ability to adjust itself to all classes of irregularities without disturbing the operative relation of the record groove and reproducing style is due to the fact that the reproducer is loosely mounted so that it is free to move not only laterally, but also in a direction normal to the surface of the tablet, which I take it is what your question means by "vertical movement."

XQ195. Suppose under the conditions stated in the preceding question, the wabbling of the tablet amounted to say one one-hundredth of an inch in a direction normal to the plane of the tablet at the point where the style ought to engage the record groove. Would this not be sufficient to utterly destroy the reproduction?

A. I would not undertake to state just what the effect of a wabbling to the extent indicated by your question would have.

XQ196. The patent states that one one-hundredth of an inch is a proper depth for the record groove.

408 Now, with such a record groove, if in the act of wabbling the tablet moves to the extent of one one-hundredth of an inch away from the stylus, which is supposed to be clamped against movement towards the tablet, I suppose you will admit that under such conditions it is mathematically impossible that there should be at that moment any reproduction whatever?

509 A. Such a disturbance of the record tablet under the conditions contemplated in your question would doubtless materially injure or interfere with the correct reproduction of the record. Whether it would absolutely prohibit reproduction or not it would be impossible to state. The diaphragm of the reproducer might be of such a character and might be so strained when it was originally adjusted into relation with the record as to respond to a disarrangement of the one one-hundredth part of an inch without absolutely interrupting the reproduction. I would not, however, undertake to state what would or would not be the effect of the disturbance you mention and only suggest the above as indicating elements which would enter into the problem and prohibit a positive statement as to the result.

510 XQ197. Your idea then is that the relaxing of the strained diaphragm might be sufficient to give to the style that movement which under the construction with the universal joint would be given to the style by gravity or spring pressure. Could you convey an idea of the extent of movement which a diaphragm would thus give to the style? Could you say that this movement might be as great as one one-hundredth of an inch?

A. In the first place it is not my idea that with the reproducer rigidly mounted against movement normal to the plane of the record tablet that the relaxing of the strained diaphragm would necessarily be sufficient to give to the style that movement which under the construction with the universal

joint would be given to the style by gravity or spring pressure. It is one of the marked advantages of the universally mounted reproducer that the pressure with which the style bears upon the record may be nicely adjusted so that the style and the record undulations may at all times be in ideal relation. With a rigidly mounted reproducer this nicety of adjustment would be impossible as the diaphragm must be strained to such a point as to enable it when re-acting to hold the reproducer in contact with the record even when subject to slight variations due to wobbling and disarrangement.

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It would result from this that the rigidly mounted reproducer would necessarily bear with an average pressure upon the record much exceeding that in the case of the universally mounted reproducer, and this excess of pressure would have a damaging effect upon the record. In fact successful reproductions from a commercial standpoint could not be obtained by the use of a rigidly mounted reproducer. In case of the rigidly mounted reproducer I would not undertake to state to what extent the movement due to the relaxing of the strained diaphragm might be.

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XQ198. Now, Mr. Cameron let us be clear about this point. The patent states, and you have yourself quoted this part of its language, that the movement parallel to the face of the tablet would by itself allow the style to follow and adjust itself to the record to a useful extent. This assumes, as I understand it, that even if the reproducer were clamped against movement toward or from the record tablet, the style would still adjust itself to the record to a useful extent. By a useful extent I understand such an extent as may at all be of any use.

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Now you have admitted that if the tablet in wobbling moves away from the style to the extent of one one-hundredth of an inch, there could be

514 no reproduction at all at that moment unless the elasticity of the strained diaphragm supplied the movement toward and from the tablet which would otherwise be supplied by the universal joint. Does it not appear from all this that a movement of the style by the strained diaphragm to the extent of one one-hundredth of an inch would really allow the style to adjust itself to the record "to a useful extent?"

515 A. Without endorsing the correctness of the statement contained in your question as to what I have or have not admitted I have no hesitation in saying that any movement of the style which will maintain it in contact with the undulations of the record would be a useful one, but the patent states that the movement parallel with the face of the tablet would not only allow the style to "adjust" itself to the record, but would also allow the style to "follow" the record to a useful extent, and this latter statement, viz., that the style is allowed to "follow" the record certainly does not refer to any movement of the style to and from the record whether under the action of the gravity reproducer or under the action of a strained diaphragm of a rigidly mounted reproducer.

516 XQ199. But with a wobbling record and a reproducer rigid against movement toward the record, when the tablet moves away from contact with the style; you will admit, I suppose, that there could be no movement parallel to the record either, seeing that such parallel movement must be given to the style by the walls of the record groove?

A. The passage of the patent quoted, that is, that passage which states that the movement parallel with the face of the tablet would by itself allow the style to follow the record to a useful extent does not state that such following of the record would occur with a wobbling or any other particular disturbance of the record. In case the record tablet were a practically true sur-

face and that the same moved with regularity in its revolving movement but was interrupted in its right line or longitudinal movement past the style, a reproducer which was mounted so as to have free lateral movement parallel to the face of the tablet would be enabled to follow the record notwithstanding the interruption to the right line movement of the tablet, and this would occur even though the reproducer were held against movement toward and from the surface of the tablet. A reproducer which is thus capable of following and remaining in operative relation with the record would certainly be one that would follow the record "to a useful extent." That there might be conditions devised by the ingenuity of one seeking to prevent the working of the apparatus is undoubtedly true. And that there might be conditions wherein a reproducer which was free to move laterally only would not be able to follow the record to a useful extent is likewise true, but this would not in my opinion negative the truth of the assertion contained in the patent that the movement of the reproducer parallel to the face of the tablet would enable it to follow the record to a useful extent. In a case where the movement of the reproducer parallel with the face of the tablet was due to the action of the record groove upon the style, it is undoubtedly true that the reproducer could not be given its lateral movement if the style were out of operative relation with the groove.

XQ200. The conditions of the apparatus of the patent here under consideration are such that any lateral movement that the style may have after it has engaged the record must be given to it by the record groove. Is this true?

A. I think that is correct.

XQ201. Now in your answer to XQ199 you have assumed that the record tablet has a true plane surface and that it moves in its rotation in such true plane; and that the style has been adjusted

520 in proper relation to the record for the reproduction. Under such circumstances the style is not called upon to "adjust itself to the record to a useful extent" since it has once forever been adjusted to the record and you have introduced conditions that will prevent a disturbance of that adjustment. You have stated that under these conditions the movement parallel with the face of the tablet would by itself allow the style to follow the record to a useful extent. Is it then your idea that the freedom of the style to adjust itself to the record to a useful extent predicated in the patent upon the movement parallel with the face of the tablet, means that the style will not be required, will not be called upon, will have no occasion to adjust itself to the record?

521 A. Counsel will pardon me if I disagree with the statement contained in his question to the effect that I have in the conditions assumed by answer to NQ199 "introduced conditions that will prevent a disturbance" of the adjustment of the reproducing style when the same has once been secured. Such disturbance would not only not be prevented by the conditions which I supposed, but would be continually occurring. If a record groove was formed in an absolute mathematical spiral upon the tablet and the reproducing style clamped in position to enter the groove at any point and the record was then advanced in exact accordance with the pitch of the spiral past the point of the style, it is true that the style might remain in operative relation with the groove from the beginning to the end thereof. But in actual practice these conditions do not hold good. In the formation of the record the cutting style does not cut a perfect and absolutely mathematical spiral. There constantly occurs slight disturbances due to jars, disarrangements of the machine or imperfections in the construction thereof, and these disturbances result in a record groove which is not at

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all times a perfect spiral. It follows from this that while the style of a reproducer might be adjusted in position in the record groove at the beginning thereof, it would not, unless it had freedom of lateral movement, be enabled to conform to the irregularities due to such disturbances as I have mentioned. If, however, the style possessed freedom of lateral movement, this would by itself enable the style to adjust itself to these irregularities in the spiral and such automatic adjustment would certainly be a very useful one.

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It is not therefore my idea that the freedom of adjustment of the style referred to in the passage of the patent under consideration means that the style will have no occasion to adjust itself to the record. On the contrary the passage to my mind demonstrates that Messrs. Bell & Tainter appreciated the fact that in order to successfully reproduce a sound record the style must not only be brought into proper operative relation with the record groove in the first place, but that it must be enabled to automatically adjust itself to the many and various irregularities which are unavoidably present in the record and that furthermore it must not only possess the power of automatic adjustment, but it must also be enabled to "follow" the record at all times.

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XQ202. You have always made a distinction between the performance of the style in following the record and its performance in adjusting itself to the record; and you said that the following of the record by the style is accomplished by its lateral movement. Adopting then your classification and assuming, as you have assumed, that the record tablet be a perfect plane and that it moves in a perfect plane; and at the same time assuming that the record groove is not a true mathematical spiral but deviates therefrom rather boldly, under such conditions with the reproducer clamped against movement toward and from the record

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526 tablet, it would seem to me that if the style were once adjusted in proper relation to the record it would never be called upon to have any other movement than one parallel to the record in order to follow the record, no matter how boldly the groove deviated from a true mathematical spiral. Of course I here except the vibratory movements of the style due to the undulations in the bottom of the record groove. Please state whether I have stated the conditions correctly?

527 A. Under the conditions assumed by your question I do not now recall any movement that the style would be called upon to make in order to follow the record other than a movement parallel with the face of the tablet.

XQ203. The conditions which I have assumed in the preceding question are exactly the same which you have assumed in your answer to XQ199 and in other answers. Under these conditions when the style moves parallel with the face of the tablet and thereby follows the record, do you mean that following the record is the same thing as adjusting itself to the record. In other words, have you given up your classification by which you distinguished between following the record and adjusting itself to the record?

528 A. I certainly have had no idea of intimating in any of my answers that I regarded the following of the record by the style and the adjustment of the style to the record as being identical, for I regard them as two entirely distinct matters. In the conditions which we have assumed in connection with several of the previous questions there has been one very radical difference. In some of the questions it has been expressly assumed that by reason of some disarrangement of the machine the record tablet while still revolving failed to advance in a right line past the point of the style, whereas in connection with some of the other questions no such condition has been assumed. Now

in case the record tablet continues its revolution but fails to advance past the point of the style in a right line the style could not possibly follow the record groove if it were held rigidly against lateral movement parallel with the face of the tablet. If, however, it possessed such freedom of movement it would, as stated in the patent, be free to follow the record. If, however, the record tablet not only revolved but was advanced past the point of the style in a right line as it is intended to do under normal conditions, the style would not be called upon to follow the record in the sense which we have just indicated, but would remain in the groove by reason of the right line advancement of the tablet. There would remain, nevertheless, the departures from the perfect spiral in the formation of the record groove which, unless means were provided for avoiding it, would throw the record style out of adjustment with the record groove. The freedom of lateral movement, however, enables the style to adjust itself to these slight irregularities and imperfections of the record automatically, so that the style remains in operative relation with the undulations. It will therefore be apparent that the ability to "follow" the record under certain conditions and the ability to "adjust" itself to the record under certain conditions are distinct functions of the reproducer both of which are however due to its freedom of lateral movement.

XQ204. I understand now your position to be this, when the record fails to advance past the point of the style in a right line and the style moves laterally to make up for this discrepancy so as to still remain in the groove, you call this "following" the record; while when it happens that the record groove is not a true spiral and the style by virtue of its lateral movement makes up for this discrepancy so as to still remain in the groove, you call this "adjusting" itself to the record. Have I correctly stated your position?

532 A. The conditions you mention would be correct illustrations of following the record and adjustment to the record, as I understand it.

XQ205. You have not yet stated whether in the preceding question I have correctly stated your position? Please do so.

A. I think this statement is substantially correct.

533 XQ206. Will you now please point out in the patent No. 341,214 where it appears that a lateral movement of the style called for by the failure of the tablet to move in a straight line means "following" the record; while a lateral movement of the style called for by reason of the deviation of the groove from a true spiral is called or means "adjustment" of the style to the record?

534 A. There is no such statement in the patent or any specific illustration of what is meant by the word "follow" or "adjust" as employed in the specification, and I have not stated that there is. I have merely given illustrations of certain conditions under which the style might be called upon to follow the record and other conditions under which it would be called upon to automatically adjust itself to the record, both being due to the freedom of lateral movement of the style, without meaning to imply that the specific illustrations given were specifically and directly mentioned in the patent.

XQ207. But since this is your understanding of the meaning of the patent you will certainly be able to point out in the same, some place, some sentence or statement that will convey the idea in some manner that lateral movement of the style called for by the failure of the tablet to advance in a right line means "following" the record; and the lateral movement of the style called for by deviations of the groove from a true spiral means "adjusting" the style to the record?

A. The patent states, lines 68 *et seq.*, page 4, that there always exists a liability for disarrange-

ment in some part of the machine or the recorder, or the support therefor, or the tablet, or its support, and further states that it would be difficult to insure that the reproducing style should touch the record at precisely the proper point if the reproducer were held rigidly. It further proceeds to state that the patentees overcome this difficulty by means of a loosely mounted reproducer. It points out that this loose mounting of the reproducer is secured by the employment of a universal joint, whereby it is free to move in any direction, and adds that the movement parallel with the face of the tablet would, however, by itself allow the style to follow and adjust itself to the record to a useful extent. When the patent says that it would be difficult to insure that the reproducing style should touch the record at precisely the proper point it uses a general expression to define what might be summed up in one word, viz., "adjustment." Adjustment may be and is in the first place secured by hand, that is, the point of the reproducing style is placed where it will touch the record at the proper point. In response to counsel's question I cited examples wherein under conditions named the style might be called upon to adjust itself to the record, viz., maintain itself in such position that the point of the style would touch the record at all times at precisely the proper point. Furthermore, I also gave illustrations wherein under the conditions named the style would be called upon to follow the record groove. I think that everything that I have said in connection with the adjustment of the style to the record or of the style following the record is fully justified by that portion of the specification contained between lines 68 to 84, page 4 of the patent when interpreted with an ordinary knowledge of the English language and the art to which the patent relates. As I understand, the correct reading and interpretation of patents demands that

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538 we should seek to ascertain what is meant by the patent as a whole, bringing to bear thereon a knowledge of the art to which it relates. Reading this patent with this understanding, I have no hesitation in stating that when the patent states that the movement of the reproducer parallel with the face of the tablet would by itself allow the style to follow and adjust itself to the record to a useful extent, that it meant to indicate broadly that the invention was not to be limited to a reproducer which had universal movement, but that it contemplated freedom of movement in a lateral direction only as falling within the scope of the invention and that it pointed out that such lateral movement would be useful in that it would allow the automatic adjustment of the style to the record and would also permit it to follow the record. I have pointed out in the course of my deposition that both of these functions exist, and that they are useful.

539 XQ208. From your last answer which I hold not to be fairly responsive to the question, it appears that it is your opinion that a reproducer that does not bear either by gravity or by spring pressure upon the record and has no freedom of movement toward or from the record, but has freedom of movement parallel with the face of the record, would come within the scope of this patent No. 341,214?

540 A. It certainly would. The patent clearly points out in lines 81 to 84, page 4 of the description, that a construction wherein the reproducer has freedom of lateral movement only is recognized as wholly within the scope of the invention; and Claim 20 calls for a reproducer loosely mounted on a suitable support so that the reproducing style is capable of a lateral movement and may in consequence thereof adjust itself automatically on the record, thereby not only indicating that such a construction is within the scope of the inven-

tion, but explicitly claiming the same. It is true that Claim 20 is not limited to a construction having lateral movement only, but it clearly includes such a construction for a reproducer mounted so as to have freedom of movement parallel to the face of the tablet only would undoubtedly be included in the phrase, a reproducer loosely mounted on a suitable support.

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XQ209. It follows from this your interpretation of Claim 20 of the patent, does it not, that if it could be shown that a sound reproducing apparatus in which the reproducer is so loosely mounted on a suitable support that the reproducing style is capable of lateral movement, and may in consequence thereof adjust itself automatically on the record, existed or was described and illustrated before the date of the invention of this subject-matter by Messrs. Bell and Tainter, Claim 20 of the patent would be invalid?

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A. That is a question of law rather than of fact, but I believe it is a principle of patent law that whatever infringes if later, anticipates if earlier.

XQ210. And with such construction of apparatus, if the tablet should not happen to be a mathematical plane, and should not move strictly in such plane, but should deviate from that plane to the extent of say one one-hundredth of an inch, reproduction could not be obtained?

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A. I have not so stated and would not so state.

XQ211. No, you have not so stated. You said that you would not undertake to state just what the effect of such wobbling would be. But will you now please state how under these conditions there could possibly be reproduction when the tablet is moving away from the style and the style is unable to follow it up?

A. If the relative action of the undulations constituting the sound record and the style were such that the style could not remain in operative relation with the undulations, correct reproduction

544 could not be obtained, because the vibrations of the reproducing diaphragm would not be controlled by and be in accordance with the undulations of the record.

XQ212. Now an apparatus constructed as called for by Claim 20, if it had nothing else except what is called for by that claim, that is to say, if the reproducer were capable only of a lateral movement, has exactly the conditions under which when the tablet wobbles to the extent of one one-hundredth of an inch the style is from time to time, entirely out of operative relation with the record. Is this true or is it not true?

545 A. In the first place Claim 20 is not limited to any such construction as is indicated in your question, viz., to a construction capable of lateral movement only, though it is broad enough in its terms to include such construction. Whether or not a style which is capable of lateral movement only would or would not be thrown out of operative relation with the record in case the tablet wobbles to the extent of one one-hundredth of an inch, I am unable to state. It might under some conditions, and it might not under others.

546 XQ213. Please observe that the patent makes the depth of the record groove one one-hundredth of an inch; also please observe that in the commercial machine the record groove is much shallower than that. Now with such a groove and with such wobbling as I have stated in the preceding question, is it not mathematically certain that the style will be out of engagement with the record groove?

A. The patent states that "a penetration of one one-hundredth of an inch has been found very effective," but I find nothing in the specification limiting the depth of the record groove to one one-hundredth of an inch, and the same may be more or less than this, experience demonstrating that a shallow groove is preferable. With a record

groove of one one hundredth of an inch in depth, however, I do not think it is a mathematical certainty by any means that the style will be out of the record groove if the record tablet wabbles to the extent of one one-hundredth of an inch. 547

Adjourned to Wednesday, September 13th, 1899,
at 10:30 a. m.

Wednesday, September 13th, 1899,
10:30 a. m.

Met pursuant to adjournment.

Present: Parties as before.

Mr. Lyons continues cross-examination of Mr. Cameron. 548

XQ214. You say in your answer to XQ213 that with a record groove of one one-hundredth of an inch in depth it is by no means a mathematical certainty that the style will be out of the record groove if the record tablet wabbles to the extent of one one-hundredth of an inch. Will you please state what would keep the style within the record groove under these conditions?

A. Certainly. The tablet might wobble towards the style instead of away from it. In that case the penetration would be two one-hundredths of an inch rather than one one-hundredth. Furthermore, the tablet might wobble slightly from and slightly towards the style, in which case the style would still remain within the record groove at all times, sometimes being further in the groove than at others. The only way in which a wobbling of the record tablet to the extent of one one hundredth of an inch would serve to withdraw the style entirely from a record groove which was one one-hundredth of an inch deep and the style normally resting in the bottom thereof, would be when the tablet wobbled or withdrew to the extent of one one-hundredth of an inch 549

550 away from the point of the style I would also observe that if in the form of record described in the patent No. 341,214 the recording instrument be placed in contact with the record tablet, the point of the style would be embedded in the surface of the tablet to a slight extent and if the mechanism were operated in the absence of sound, a groove of even depth would be cut by the recording style in the surface of the tablet. Upon sounds being directed against the diaphragm of the recorder, however, the groove would be formed of unequal or varying depth, being deeper at any portion than the normal penetration in the absence of sound, and in other parts being shallower than the normal penetration, thereby forming the undulations and depressions corresponding to sound waves. If the normal penetration was the one one-hundredth of an inch, the record groove would at some places be of greater depth and some places of less depth than one one-hundredth of an inch. As I remarked, however, in my answer to XQ213, the sound groove as the same is now formed in the actual practice of the art and in machines constructed in accordance with the principles of the patent in suit, is much less than one one-hundredth of an inch in the average depth.

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552 XQ215. It is highly desirable that you make an effort to understand my questions and I promise to make an effort to make them as clear as possible. I was not at all speaking or asking anything about the effect of wobbling while the record is being made; my question had only reference to reproduction; and still you started your answer by describing the effect of wobbling while the record is being made. If I were to follow your lead this examination would have to be extended to an intolerable length.

Now please assume any reasonable depth of record groove, I don't care which, and assume that in the act of reproducing or in the attempt of repro-

ducing, the record tablet wabbles to the extent of the maximum depth of record groove that you have assumed. By wabbling I mean both a movement toward and a movement from the point of the style; an oscillatory movement. This I suppose is the meaning of "wabbling." Now under such conditions, if the reproducer is rigid, or is clamped, with respect to movement toward and from the tablet, is it not a fact that the style point will in successive moments be quite free of the record groove, then again slightly engage it and continue to engage it more and more, and eventually engage the bottom of the groove and then tend to dig into the bottom of the groove; and then again gradually withdraw from the groove until it is free of the same; and so forth in rythmical repetition; and that in this manner reproduction would at certain moments cease altogether and at others be exceedingly imperfect?

A. With a record groove having undulations and depressions in the bottom of the groove corresponding to sound waves and a reproducer clamped so that it could not move toward or from the record tablet and with its style resting in contact with the bottom of the groove, if the record tablet moved away from the point of the style to an extent exceeding the strain placed upon the diaphragm of the reproducer when the same was adjusted into operative position, the style would no longer remain in contact with the record and for just so long a time as this condition prevailed reproduction would cease. Whether or not a movement of the tablet away from the reproducer a distance equal to the depth of the record groove would be sufficient to overcome the strain placed upon the diaphragm of the reproducer and thus withdraw the style from contact with the record, would depend entirely upon the depth of the groove and the strain upon the diaphragm. If, however, the record instead of being in the form

556 of undulations and depressions in the bottom of the groove were a laterally sinuous or zig-zag record groove of even depth, and the style were adjusted in the groove normally in contact with the bottom thereof, a—

By the Magistrate:

At the request of counsel for defendants. The above eight lines on page 177 of the typewritten record is cancelled at the request of witness before proceeding with his answer; the witness then continues:

557 wabbling of the record toward the style would result in greatly increased friction of the style upon the bottom of the record groove which might even go to the extent of interrupting the movements of the machine, or it might not. In case it did not, the return oscillation of the tablet would certainly not result in withdrawing the reproducing style from the record groove. In case, however, the first movement of the tablet in its oscillation was from rather than towards the style, an oscillation equal to the depth of the record groove would of course withdraw the style to a point exactly even with the upper line of the groove at the tablet surface.

558 With a record formed in wax or wax-like material with the undulations in the bottom of the groove, if the oscillation of the tablet was first toward and then from the style the effect would be to produce increased and probably injurious pressure of the style upon the record, but would on the return oscillation probably not withdraw the style from the record as the strain of the diaphragm would in all probability act to retain it in contact with the record.

XQ216. You have I suppose manipulated a variety of sound recording and reproducing machines. Could you not, with the knowledge that you have derived by such experience, give an approximate

idea of the distance which the relax of the strained diaphragm would carry the point of the reproducing style? 559

A. This would vary greatly with the size, material of the diaphragm, and the strain to which it was subjected. With a large diaphragm, other things being equal, it would be greater than with a small diaphragm. And with a machine using a light reproducer it would be much less than with a machine using a heavy reproducer. As there are a number of materials that are and have been employed in forming a diaphragm and as the sizes vary considerably, as the strain placed upon the diaphragms is different in different machines, and as I have never undertaken to observe the operation of the various diaphragms under the various conditions mentioned, it would be impossible for me to state what the relax from the strain would be. 560

XQ217. You have here in this room, I suppose an ordinary commercial graphophone, and you surely have here in this room an ordinary commercial gramophone. Will you be so kind to find out from these machines how much the point of the reproducer style would be moved by the relax of the strained diaphragms in both machines?

A. In the gramophone the diaphragm would not be placed under any strain by the mere act of adjusting the reproducer into operative relation with the record. I have, as is stated in your question, a small graphophone at hand, but to determine with any accuracy what movement of the style point would result from placing the diaphragm under the strain due to the adjustment for reproduction would require a nicety of experiment and delicacy of measuring instruments which I have not now at my disposal. 561

XQ218. Could you not do this within the limits of accuracy of fifty per cent., or seventy-five per cent. or one hundred per cent. without measuring

562 instruments of any particular nicety. If you can do it within the limits of accuracy of one hundred per cent. it would throw some light upon this subject?

A. I certainly will not undertake experiments and measurements involving movements to be measured by the thousandths of an inch without proper facilities for obtaining fairly accurate results, and I must decline to undertake merely guesswork experiments. I do not anticipate that such experiments would throw light of any value whatever upon the subject.

563 XQ219. This is quite satisfactory since as it appears from your answer the work would require a measuring instrument reading to one one-thousandth of an inch in order to come within one hundred per cent. of the length of movement which would be given to the style by the relax of the strained diaphragm.

Now, keeping this in view, please answer now that part of XQ215 which you have not yet answered; that is to say, state whether under the conditions which you were called upon to consider in that question reproduction would at certain moments cease altogether and at others be exceedingly imperfect?

564 A. I have no change to make in the answer which I gave to XQ215. Whether or not the reproductions would cease at certain moments and be exceedingly imperfect at others would depend entirely upon the character of record, the character of the diaphragm employed, the adjustment thereof with relation to the record, and the direction which the tablet might take in its initial movement, that is, whether it moved toward or from the style. Under certain combinations of these conditions it is quite probable that reproductions would momentarily cease and at other times be imperfect. On the other hand with different combinations of these conditions it is quite prob-

able that the reproductions would not be interrupted nor very materially interfered with. 565

XQ220 Can you make a statement as respects the number of sound vibrations that would be recorded upon one turn of the spiral track on a tablet of the kind shown in Patent No. 341,214 in suit?

A. It would be impossible for me to make any such statement.

XQ221. Suppose the sound recorded has in it definite pitch which you may assume; also suppose the tablet to be of a certain diameter which you may assume; could you not then give an idea, approximately of the number of sound vibrations that would be recorded on one turn of the spiral? 566

A. I could not, nor could anyone else.

XQ222. Assume further that the tablet is rotated with a speed upon which you may fix, but preferably such speed as is ordinarily given to machines of this character. Could you not then give an idea of the number of sound vibrations that would be recorded on one turn of the spiral? Of course it is understood that a dozen, more or less, of sound vibrations need not trouble you?

A. The pitch of any sound is determined by the number of sound vibrations per second. Given the number of vibrations per second, a spiral of a certain length, and the time consumed by said spiral in moving under the point of the style, it is a simple matter of calculation of course to determine the number of vibrations recorded in a single spiral of the tablet. In the absence of any information as to the specific diameter of the tablet described in the patent I could not, however, undertake to state the number of vibrations that would be recorded in a single spiral thereof. 567

XQ223. I really do not care for a computation of this sort; but what I wish you to state is in a rough manner how many vibrations would be found recorded upon a spiral of any reasonable practice-

568 able length with the tablet moving with commercial speed, and the sounds recorded to be of any pitch that is ordinarily used, say in speaking with a man's voice? You certainly can make a statement that would come somewhere near the actual fact?

A. Any man in speaking changes the pitch of his voice materially, and frequently a number of times in a single sentence. Every change of pitch would change the rate of vibration of the sound wave. In recording sounds all talking machines are run at various speeds within a certain limit, and the number of vibrations obtained in a single spiral of any given length would of course vary with the rate of speed with which the tablet is revolved. Such being the facts, it would manifestly be impossible for any one to make even an approximate guess at the number of vibrations to be found in a single spiral under the conditions named in your question.

569 XQ224. I see that you do not yet understand what I requested you to do. But you have here in this room probably a graphophone record and you surely have in this room one or more gramophone records. Now please take any one of these records, inspect it, and estimate roughly the number of sound vibrations recorded in any one turn of the spiral or of the helix. You need not attempt to count the vibrations, since it will be all sufficient if you state their number quite roughly?

570 A. The only way in which any approximately correct statement of the number of vibrations could be obtained, whether the same be a single turn of the spiral of the gramophone record, or a single turn of the helix in the graphophone record, would be to count the number of vibrations from one end of the turn to the other. The pitch of the sound recorded in a single turn may vary greatly from one end to the other thereof. A count of the number of vibrations recorded in the

first one-tenth of the length of the turn would give no indication of what number of vibrations would be found on the other nine-tenths. The first one-fifth of the turn might have thereon a greater number of vibrations than would be found on the other four-fifths, and *vice versa*. 571

XQ225. I suppose you would be willing to say that there are quite as many as ten vibrations recorded on any one of the spirals of the gramophone record which you now hold in your hand?

A. Certainly.

XQ226. You would probably be willing to say that there are quite as many as twenty vibrations recorded on any one of the spirals of the same gramophone records? 572

A. Yes, sir; there are doubtless more than one hundred vibrations recorded in any one of the turns of the spiral wherein the sound is recorded at all.

XQ227. This will suffice for the present purposes. Now please state how many times a record tablet is likely to wobble during one revolution?

A. I could not possibly do so.

XQ228. You thought first that you could not possibly estimate the number of vibrations recorded upon a single turn of the spiral of a record tablet; but you finally succeeded in making a rough but sufficiently accurate statement in this respect. Will you therefore please make a similar effort with respect to the number of wabblings. Is it not a fact that the wabbling of such a record tablet as is shown in the patent here under consideration would be due either to the fact that the shaft upon or with which the tablet turns has a loose bearing, or because the tablet is not mounted straight, that is, perfectly at right angles upon the shaft; and is it not a fact that in consequence of these defects the tablet would wobble either once or twice and not more for each revolution? 573

574 A. Your question is incorrect wherein it states that I have estimated the number of vibrations recorded upon a single turn of the spiral of the recorded tablet. I have not done so further than to state that it probably exceeds a hundred in the particular tablet to which my attention was called. This is no estimate of the number of vibrations found in a single turn of the spiral, as there may be hundreds or even thousands of vibrations thereon. Whether it is one or the other I would not undertake to state. With regard to the irregular movements of the tablet which you refer to as "wabblings" these may be due to a large number of causes among which are the defects in connection with the shaft which you have mentioned. If a shaft was in any way out of proper position, each turn of the shaft would of course tend to produce two vibrations or irregularities in the movement of the tablet. If the irregularities, however, were due to other defects of the machine, or to irregular warpings in the tablet itself, the number of wabblings or vibrations of the tablet for each turn thereof might vary greatly.

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XQ229. You are, however, willing I suppose, to say that the number of wabbles of the tablet would be much less than the number of vibrations recorded upon a single turn of the record groove?

576 A. Yes, sir; I should say they would be.

XQ230. This being the case, does it not strike you that when you explained in a preceding answer that it will depend upon the fact whether, in wabbling, the tablet moves first toward, or first from the point of the style, whether the latter will come out of contact with the record, you made a mistake?

A. It does not.

XQ231. Since, according to your present testimony, the reproducing style may vibrate hundreds and thousands of times during the same time that the tablet wabbles two or more times, but surely

never as many times as the style is called upon to vibrate; what difference can it make whether the wabbling begins with an approach to the stylus or with a recession from the same? 595

A. Your question wholly ignores the fact that many of the vibrations of the sound record are but through the fraction of the one-thousandth part of an inch; whereas the irregularities in the movement of the tablet as a whole may be and sometimes are as great as a quarter of an inch, and that therefore the movement of the style when responding to the irregularities constituting the sound record may be safely ignored when considering the movement of the reproducer as a whole when responding to the irregularities or wabblings of the tablet. 596

XQ232. Now let us assume the figures and dimensions which you have just stated. Let us assume a sound record represented by a groove having an average depth of one one-hundredth of an inch, but tapering down to a depth of merely a fraction of one one thousandth of an inch, and let us assume a wabbling of the tablet which may amount to as much as one-quarter of an inch. You say that this is not only possible but does occur. Now under such conditions when the reproducer is rigid against movement toward and from the tablet, but has all imaginable freedom of movement parallel to the face of the tablet, do you hesitate to say that the style will alternately be entirely out of contact with the tablet and again dig into it to the depth of nearly a quarter of an inch; or else will break the machine, or will stop it, and that reproduction under such conditions is an absolute impossibility? 597

A. With a record groove of the kind your question suggests and a reproducer mounted as stated in your question, a tablet which oscillated towards and from the reproducer point to the extent of a quarter of an inch would undoubtedly throw the

580 reproducing style out of operative relation with the record groove and successful reproduction would be impossible.

XQ233. How then, would under such or similar conditions, the movement of the style parallel with the face of the tablet come about, and how would it, if it came about, allow the style to follow and adjust itself to the record to a useful extent.

581 A. Under the conditions assumed in my answer to the last question, the style would not be able either to adjust itself to nor to follow the record groove to any useful extent, that is even if originally adjusted into position it would undoubtedly leave the groove before a complete turn of the record tablet was made. But because there are conditions under which a style which has freedom of lateral movement only would not adjust itself to and follow the record, it by no means follows that in the great majority of cases and under ordinary operative conditions that the style would not automatically adjust itself to the irregularities found in the record as well as follow the record. Under the very conditions, however, which were assumed in my answer to XQ233, the great value of the universally mounted reproducer becomes apparent. It is enabled to automatically adjust itself to the record whether the same wobbles
582 toward or from the reproducing style, and thereby at all times maintain the style in ideal operative relation with the undulations of the record groove.

XQ234. In patent No. 341,214, on page 4, lines 62 to 67, the following appears:

"No special care is necessary to insure its adjustment, for if the reproducer K be allowed to rest against the record with the style upon the engraved line, the style will of itself gravitate to the bottom of the groove."

Will you please state whether this passage does or does not refer to the manner in which the style adjusts itself to the record?

A. With the record formed in the shape of elevations and depressions at the bottom of the groove, it is essential for successful reproduction that the rubbing style rest upon the elevations and depressions. With the old style of Edison reproducer it was necessary to exercise the utmost care in adjusting the point of the style into proper operative relation with the record groove. This was so difficult of a feat that none but an expert could successfully accomplish it. The universally mounted reproducer, however, enabled the style to automatically gravitate to the bottom of the groove thus automatically effecting that particular form of adjustment. It is still necessary, however, to bring the reproducer point into a position where it may gravitate to the bottom of the groove, and in the sentence which you have quoted this is accomplished by allowing the reproducer to rest against the record. That kind of adjustment which consists in placing the point of the reproducing style against the record surface with the proper pressure, is I think, properly described in the sentence which you have quoted by the use of the words "will of itself gravitate to the bottom of the groove." When the machine is in operation, however, it is necessary in order to maintain the rubbing point in contact with the record at the bottom of the groove that it should not be allowed to deviate from the groove itself. This it would be inclined to do in response to slight departures from a perfect spiral in the record groove which I have heretofore mentioned, did it not possess the power of automatically adjusting itself to the groove in response to these irregularities. That kind of adjustment described as gravitating to the bottom of the groove is due to the freedom of movement of the style in a direction toward and from the face of the tablet, while the other kind of adjustment which enables it to remain in the groove notwithstanding the irregularities con-

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592 stituting a departure from a perfect spiral is due to the freedom of lateral movement mentioned in lines 81 to 84, page 4.

Adjourned to Thursday, September 14th, 1899, at 10:30 a. m.

Washington, D. C., Sept. 14th, 1899,
10:30 a. m.

Met pursuant to adjournment.

Present: Parties as before.

593 Mr. Lyons continues cross-examination of Mr. Cameron.

XQ235. Will you please state the scope of claims 19 and 20 of Patent No. 341,214 in suit; and if there is any difference in the scopes of these claims please point it out?

594 A. Claim 19 is for a reproducing style with any mounting for such style which leaves the style free to move laterally, while claim 20 is to a reproducer which technical expression includes not only the style but the vibratory member, such as the diaphragm, loosely mounted on a suitable support so that the style is capable of a lateral movement, the result of both constructions being that the style is enabled to adjust itself automatically to a record. Under the construction defined in claim 19 I understand it that any mounting for the reproducing style which leaves the style free to move laterally and thereby adjust itself automatically to a sound record would be included whether the reproducer as a whole were loosely mounted or not; whereas under the construction defined by claim 20 the reproducer as a whole must be loosely mounted so that the reproducing style is capable of a lateral movement in consequence of which it may automatically adjust itself to the record. Claim 19 is broader in scope than claim 20, and

would, in my estimation, include the construction defined by claim 20 as well as other means of mounting the reproducing style which would leave it free to move laterally to such an extent that it might adjust itself automatically to the sound record.

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XQ236. In other words according to your views claim 19 would cover the case where the reproducer as a whole is mounted rigidly, but where the reproducing style itself is so mounted in the reproducer that it is free to move laterally. Do I correctly state your view?

A. Not quite. The freedom of lateral movement must be such as to enable the reproducing style to adjust itself automatically to the record. With that modification your question fairly states my view.

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XQ237. Is such construction of apparatus indicated in the patent?

A. A construction of apparatus broadly stated which leaves the style free to move laterally and adjust itself automatically to a sound record is indicated in the patent.

XQ238. I mean the construction wherein the reproducer as a whole is rigidly mounted but the style is so mounted on the reproducer as to be free to move laterally. If such a construction is pointed out in the patent please indicate it.

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A. In lines 84 to 86 on page 1, the patent states that

"The invention consists, fourthly, in loosely mounting the reproducing style so that it can readily be guided by the record. Preferably the reproducing style, or rather what may be called the head of the reproducing instrument, is mounted on a universal joint, and the style is pressed against the record by the yielding pressure of a spring or weight."

It is here clearly stated that the invention consists in loosely mounting the reproducing *style* and

592 it is pointed out that as a preferable construction the "head" of the reproducing instrument is mounted on a universal joint as a means of securing the loose mounting of the reproducing style in which this portion of the invention is said to consist.

It is therefore, I think, clearly though broadly indicated that it is only a preferable construction wherein the reproducer as a whole is loosely mounted, the invention consisting in loosely mounting the reproducing style whether the same is secured by loosely mounting the reproducer as a whole or not.

593 XQ239. You do not then find in the patent a construction with a rigidly mounted reproducer and the style loosely mounted therein so that it may have a certain freedom or lateral movement. Please refer to figs. 18, 19 and 20 and the description thereof in the patent and state whether you do not there find a reproducer head mounted rigidly, but the style mounted upon a thin rubber diaphragm which gives or allows the style a certain lateral play?

594 A. The reproducer K' of Fig. 20 is stated in the patent to be similar to that shown in Figs. 9 and 10 with two exceptions; one is that the style 26 is so placed that the point is at the centre instead of projecting beyond the edge of the instrument, so that its position on the record is not so readily seen, but the patent says:

"with the form of machine shown in these figures this is less important. The same may be said of the loose mounting of the reproducer although in point of fact the thin rubber diaphragm 38 gives a certain lateral play to the style."

The reproducing point or style riveted or cemented to the thin rubber diaphragm, as is stated in the description of the reproducer K' in connection with Figs. 9 and 10, would not be a loose-

ly mounted style, but would on the contrary be a style fixed in position. The portion of the specification which I have just quoted above, however, states that with the form of machine shown in Figs. 19 and 20, the absence of the loose mounting of the reproducer is less important and adds that in point of fact the thin rubber diaphragm 38 gives a certain lateral play to the style. That is to say, that even though the loose mounting of the style is wanting in the construction shown in Figs. 19 and 20, it nevertheless has a certain lateral play due to the flexibility of the diaphragm to which it is attached. This portion of the patent which I have quoted certainly describes a style which has certain lateral play independent of any movement of the reproducer as a whole, but whether or not such lateral play would be sufficient to allow it to adjust itself automatically to the sound record or not I am unable to state. With some sizes and characters of diaphragm it might, with others it might not.

XQ240. About the loose mounting it will be necessary to use language that is as little loose as possible. You said in your last answer that a style cemented or riveted to a thin rubber diaphragm would not be a loosely mounted style, but would on the contrary be a style fixed in position. I suppose you thereby mean fixed in position on the diaphragm, but not fixed in position in the reproducer head. Am I correct?

A. I of course did not mean that the style would not have such movement relative to the reproducer head as would be due to the flexibility of the diaphragm. I simply meant that the style was not loose in that it was capable of free movement laterally or otherwise with relation to the reproducer taken as a whole, or with relation to the machine other than such movement as might be due to the flexibility of the diaphragm itself.

XQ241. You also ascribe in the same answer to

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598 XQ239, to the patent a statement to the effect "that even though the loose mounting of the style is wanting in the construction shown in Figs. 19 and 20, etc.;" while so far as I can see the patent only says or implies that the loose mounting of the reproducer is wanting. Am I correct?

A. In my answer to XQ239, I quoted the exact language of the patent and then gave my interpretation of that language. The language speaks for itself. Whether my interpretation thereof is correct or not I will leave the Court to determine. I wish to add, however, that I did not state that that portion of my answer which you have quoted in your last question was anything more than an interpretation of the language actually used by the patent.

599 XQ242. Will you now please define in your own manner the scope of claim 21 of Patent No. 341,214 in suit?

A. This claim is so explicit that I do not see how I could define its scope any better than by quoting the claim itself. Any reproducer mounted on a universal joint, provided it is held yieldingly against the record, would be within the scope of this claim.

XQ243. Now as respects all these three claims, 19, 20 and 21, do you conceive these claims to cover a reproducing style and a reproducer respectively without combination with a record, or do you read into these claims the record as a necessary element?

600 A. Claims 19 and 20 do not in my opinion demand a sound record. Claim 19 is for two elements, a style and a mounting of a certain character. Claim 20 is for a reproducer mounted in a certain way. The terms of claim 21 demand not only that the reproducer shall be mounted on a universal joint, but that it shall be held against the record by yielding pressure and it would be impossible to comply with this last condition in the absence of a record. However, I think that a cou-

struction of claim 21 which would make it read 601
"the reproducer mounted on a universal joint and
capable of being held against the record by yield-
ing pressure" would be fairly justified by the
terms of the claim as the same are found in the
patent. Such a construction would not of course
include the record as an element.

XQ244. Now, in your answer to XQ236 you in-
sisted with respect to claim 19 that the freedom of
lateral movement of the reproducing style must be
such as to permit it to adjust itself automatically
to the record. Now, unless there is a record, some
particular kind of record, nobody could tell ac- 602
cording to your own views whether the lateral
movement is such as will permit the style to adjust
itself to the record. Would it not seem from this
that the record must be read into claims 19, 20 and
21 as a necessary element in order to bring sense
and meaning into these claims?

A. I think not.

XQ245. How would you then decide by looking
at a combination with a reproducing style of a
mounting therefor, which leaves that style free to
move laterally; whether it is thereby adapted to
adjust itself automatically to a sound record seeing
that according to your answer to XQ236 the free-
dom of lateral movement alone is not sufficient to 603
satisfy the requirements of claim 19, but that the
freedom of lateral movement must be a peculiar
one, namely, such as will permit it to adjust itself
automatically to the record?

A. If on inspecting the combination of a repro-
ducer with a mounting therefor I found, for ex-
ample, that it was mounted on a universal joint so
that it had unlimited movement in any direction,
I would be able, as would any one familiar with
the art, to state at once that the style would have
such freedom of lateral movement as to enable it
to adjust itself automatically to any sound record.
If, instead of a universally mounted reproducer,

604 the reproducer was on a mounting which gave it great freedom of lateral movement, any one posted in the art would be able to state at once that such great freedom of lateral movement would enable it to adjust itself automatically to a sound record. There might be constructions wherein the style was combined with a mounting which would enable it to move laterally, and the question or whether the style would be enabled to thereby adjust itself, automatically would have to be determined by testing the same in connection with a record. The fact that there could be constructions of this kind, does not, however, in my opinion render it
605 necessary to read a sound record as an element in the claims. Where a tablet is found with minute undulating lines thereon, said lines may or may not in the undulations thereof correspond to sound waves. No one from a mere inspection can determine whether such undulatory line is or is not a sound record. By operating such records, however, in combination with a reproducer, it can be at once determined either that it is or is not a sound record. But the fact that it is necessary to use a reproducer to determine whether the undulatory line is or is not a sound record would not make the reproducer an element in a claim such for example as claim 7 of the patent in suit. Like-
606 wise, the fact that it may be necessary to employ a sound record to determine whether or not a style has such freedom of lateral movement as to enable it to automatically adjust itself to a sound record does not in my opinion make the record a necessary element in claims 19 and 20.

XQ246. Then if you see a sound reproducer that is mounted upon a universal joint whereon it is free to have unlimited movement in any direction; or if you saw a reproducer so mounted as to give it great freedom of lateral movement you would not ask to see the record in combination therewith in order to determine whether or not it comes with-

in the scope of claims 19 and 20; but you would at once say that the structures do infringe these claims. Do I correctly understand you? 607

A. You do.

XQ247. And upon the principle which you said was a good one, that whatever infringes if later, anticipates if earlier, you would say that such structure if earlier than the invention defined in claims 19 and 20 by Messrs. Bell & Tainter anticipates these claims?

A. I would have no hesitation in stating that a sound reproducer that is mounted on a universal joint whereon it is free to have unlimited movement in any direction would anticipate either claims 19 or 20 provided it was known to the world prior to the date of the invention of that structure by Messrs. Bell and Tainter. Likewise, if I saw a reproducer so mounted as to give it great freedom of lateral movement I would not hesitate to state that if such were known to the world prior to the date of the Bell and Tainter invention, that it would anticipate claims 19 and 20. 608

XQ248. It would make no difference in your judgment, would it, whether the sound record used or intended to be used with such reproducer is one having elevations and depressions in the bottom of the groove, or is one represented by an undulatory groove of even depth? 609

A. It would not. The patent specifically states that the loosely mounted reproducer is specially adapted for use in connection with a record in the form of a groove with sloping walls, and that this combination is specifically claimed; but it adds that such loosely mounted reproducing style may also be usefully employed with other forms of record. I think there can be no doubt that claims 19 and 20 were intended to and do cover a loosely mounted reproducing style or reproducer, as the case may be, without any reference to the particular kind of record with which the same may or may not be capable of employment.

610 XQ249. If it should appear that in the constructions shown in Patent No. 341,214 the freedom of lateral movement of the style alone is insufficient to enable it to adjust itself automatically to a sound record or on the record, would you then not find yourself obliged to read into these claims both a lateral movement and also freedom of movement to and from the record in order to save these claims?

611 A. I do not conceive that it would be a part of my duty as an expert witness to make any attempt to "save" these or any other claims. I rather conceive it to be my duty to state my understanding of what constructions the claims cover and to give the Court my reasons for any position that I may assume. And this I have done.

XQ250. Now as respects claim 21, which you say makes the record an element of the combination although not so formally stated in the claim, I suppose if you found a reproducer mounted on a universal joint, that is, not held against the record by yielding pressure, you would not deem it to be an infringement of that claim?

A. Will counsel kindly point out wherein I have stated that claim 21 "makes the record an element of the combination?" I have not intentionally made such statement.

612 XQ251. In your answer to XQ243 you said:

"The terms of claim 21 demand not only that the reproducer shall be mounted on a universal joint, but that it shall be held against the record by yielding pressure, and it would be impossible to comply with this last condition in the absence of a record."

I understand this to make the record an implied element of the claim; although I do not overlook the fact that you also said in the same answer that claim 21 might also be construed so as to be satisfied if the reproducer were not actually held against the record, but were capable of being held against the record if such were present. Now,

since it seems that we do not exactly agree as to the scope which you have ascribed to claim 21, please define that scope anew, but if possible in a manner that will leave no doubt as to what you mean? 613

A. I should construe claim 21 as defining any reproducer which is mounted on a universal joint and acting in conjunction with means capable of holding it against a record by yielding pressure without regard to whether such record were actually present or not; that is, in my opinion, a machine for reproducing sounds which had universally mounted reproducer which reproducer had means for holding it yieldingly against a record, the whole being so positioned that if the record were present it could operate as a reproducer in conjunction with such record, such machine, even in the absence of a record, would infringe claim 21. 614

XQ252. Now, in your answer to XQ243 you distinctly said that the terms of claim 21 "*demand*" that the reproducer shall not only be mounted upon a universal joint "*but that it shall be held against the record by yielding pressure,*" and you added that it would be impossible to comply with this last condition in the absence of a record. You now say, if I understand you rightly, that the "*demand*" of claim 21 can be complied with in the absence of a record, or that the claim can be satisfied without a record. Will you please definitely fix upon an interpretation of claim 21 in such manner that we may hold fast to it without further deviation? 615

A. In answer to XQ243, I stated that a construction of claim 21 which did not make the record a necessary element in the claim would, in my opinion, be fairly justified by the terms of the claim. and my answer to XQ251 certainly does not depart from such a construction. The interpretation which I gave the claim in answer to XQ251 is one

616 which I believe to be a proper one fairly justified by the description of the patent and the terms of the claim itself, and I see no reason for altering such construction.

XQ253. Now suppose there were a sound reproducer mounted on an universal joint, and capable of being held against a certain record by yielding pressure but used in combination with another kind of record where it cannot be held against the same by yielding pressure, and is not held against the same by yielding pressure; would such construction in your opinion infringe claim 21?

617 A. As I stated in my answer to XQ251 I should construe claim 21 as defining any reproducer which is mounted on a universal joint acting in conjunction with means capable of holding it against the record by yielding pressure. In the suppositions structure defined by your question (and which as it appears to me is an impossible one) there would be nothing but a universally mounted reproducer, and this would not in my opinion infringe claim 21.

618 Q254. Suppose we had a laterally undulating sound record groove of even depth with mathematically vertical walls and a cylindrical stylus mounted on a universal joint pressing against the flat bottom of the groove either by the action of a weight or by a spring; would such combination come within the perview of the fourth statement of invention in the patent, and would it infringe claim 21?

A. Certainly.

XQ255. Would in such structure the style be pressed against the record?

A. Certainly.

XQ256. Suppose such record' groove as I have described be made in a soft and plastic material, and suppose the style be pressed in that groove so as to disfigure the bottom thereof; would this affect the sound record?

A. I would not undertake to say.

XQ257. Where in such sound record groove do you find the undulations which represent the sound record? 619

A. The entire groove constitutes the sound record.

XQ258. Do you mean that the sound record is also in the bottom of such groove which we have assumed to be quite flat?

A. I mean that it takes the entire groove to constitute the sound record, and that you cannot properly dissect the groove saying that this or that part constitutes the sound record and that some other part does not. A record groove of a sinuous or undulatory character whose sinuosities or undulations correspond in form to sound waves, is a sound record. 620

Adjourned to Monday, Sept. 18th, 1899, at 10:30 a. m.

Monday, September 18th, 1899,
10:30 a. m.

Met pursuant to adjournment.

Present: Parties as before.

Mr. Lyons continues cross-examination of Mr. Cameron:

XQ259. Suppose a spiral groove formed in any material but smooth both along the walls and the bottom. Would you call such a spiral groove a sound record? 621

A. It might be and it might not be. Every sound record should have a smooth surface in order to reproduce well. I presume however that your question means not so much that the groove should be smooth as that it should be free from irregularities, and a spiral groove formed in any material would not constitute a sound record unless the same was an irregular groove whose irregularities corresponded to sound waves.

XQ260. Suppose now a groove of the character

622 you have just described, namely, one that has no irregularities corresponding to sound waves and which you say is not a sound record, were changed no matter by what means, so as to have irregularities corresponding to sound waves impressed upon the side walls of the same but without at the same time impressing these irregularities upon the bottom of the groove. If now a cylindrical reproducing style is placed into this groove so as to be pressed by gravity or by a spring down upon the bottom of the groove, would you now still say that the style bears with yielding pressure upon the record that is formed in the groove?

623 A. If your question assumes that it is possible to first form a spiral groove which is free from irregularities corresponding to sound waves and then subsequently transform said groove into one that has irregularities corresponding to sound waves, I should say that the question assumes a construction which in my opinion is a practical impossibility and how a groove formed or attempted to be formed in the manner indicated would act, it might be difficult to state. If, however, you mean by your question that the sound groove is formed with irregularities in its side walls but with an even depth, I would have no hesitation in stating that such groove as a whole including
624 its side walls and bottom constitutes a sound record, and that any kind of a style whether the same was cylindrical or not that was held by gravity in operative position in the groove, was held with yielding pressure on the record. The groove having formed therein irregularities corresponding to sound waves constitutes the record and it would be as impossible to separate the groove into its various parts and say that this or that part constitutes the record while some other part does not, as it would be to separate the two sides of a sheet of paper.

XQ261. Still one side of a sheet of paper may

have something written upon it while the other side may be blank; and you could not read anything from the blank side while you could easily read from the side that has something written upon it. Now, if you look upon the blank side of such a sheet of paper would you say that your eye bears upon the record that the paper contains; similarly, the side walls of a groove, may have a sound record written or engraved upon them, while the bottom of the groove under our assumption has no sound record engraved or written upon it. How then can you say that the style bearing upon the bottom of such groove, bears upon the record?

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A. The matter written or recorded upon the surface of a sheet of paper becomes a record by reason of the lines traced upon the surface of the sheet by the pen. The line so traced constitutes the record formed upon the paper. The surface recorded upon when forming a sound record is the surface of the material in which the record groove is formed. The record groove corresponds to the lines of the writing upon the surface of the sheet of paper. The confusion arising in your mind is due to the fact that you seem to regard the record groove as the surface upon which the sound record is formed, whereas in fact the groove is itself the record and the material of the tablet is the surface upon which it is recorded. To attempt to split up the groove would be like attempting to split the hair line constituting the writing on the surface of the sheet of paper and say that one part or one side of the hair thus split constituted the record on the surface of the sheet of paper while the other part of the split hair did not. Manifestly, this is an absurd conclusion, but no more so than the proposition that a record groove in a tablet can be divided up into parts in the way assumed by your question.

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XQ262. Suppose now a record groove of the kind we have assumed is so acted upon by a chisel as to

628 cut away the undulations from the side walls and the style be now held by yielding pressure upon the bottom of the groove. Would you then still say that the style rests against the record?

A. If the chisel or cutting instrument were caused to operate on a record groove in such way as to destroy it as a record groove, so that it was no longer a record groove but simply a groove, a style could not of course bear upon a record which did not exist.

629 XQ263. Still under this second assumption the style would bear just as before the record was destroyed upon the same even bottom of the groove. How then can you say that in one case the style bears upon the record and in the other case that it does not?

A. By the action of the chisel the groove has been transformed from an irregular to a regular groove and thereby has been transformed from a record to no record. The fact that the style bears upon the bottom of the groove in both cases to my mind is not the point. The real question is, does it bear upon a sound record or does it not. If the groove has been so transformed that it no longer constitutes a sound record, then the style does not bear upon a record. If, however, the style bears in a groove which constitutes a sound record, 630 then it does bear upon a record, and this without regard to whether the original and the transformed groove have the same bottom or not.

XQ264. It is then your idea that a style may bear with yielding pressure upon a sound record even if it does not touch either the elevations and depressions or other irregularities that correspond to sound waves?

A. I have not so stated by any means.

XQ265. Well, in the case of a sound record representing by a laterally undulating groove of even depth and vertical walls with a cylindrical style bearing upon the bottom of the groove alone, the

irregularities which represent sound waves and which are only in the side walls, are not touched, as I understand it. How then, can it be said in such case that the style bears with yielding pressure upon the sound record? 631

A. Your question now imports into the groove and into the action of the style thereon two conditions not heretofore included, first, that the groove has vertical walls, second, that the style bears upon the bottom of the groove only.

In regard to the first condition I would state that in the practical art of recording and reproducing sound I am not familiar with any such groove, and in regard to the second condition I assert that in any practical sound record groove the condition assumed in the question is an absolute impossibility. Assuming, however, that there is a record groove with vertical walls and with the undulations in said walls corresponding to sound waves and that it were possible to place a cylindrical style in said groove touching only the bottom of the groove and not the side walls thereof and that the machine were operated, there would be no reproduction of sound. If, however, the style were placed into the groove so as to practically fill the groove with the point bearing therein, and the machine were operated, the irregularities on the side walls of the groove would be pressed upon by the style and the style would yield as the machine was operated so as to follow the irregularities; the amount of pressure which the style thus exerted upon the side walls of the groove would depend upon the tension of the spring or the mass of the weight by which it was held in position in the groove. I am very clear, therefore that even when the style rested with its point upon the bottom of a record groove with vertical walls and even depth, that the style would nevertheless be held against the walls of the groove with yielding pressure. 632 633

634 XQ266. You don't mean by the yielding pressure of a weight, do you?

A. Certainly, or its mechanical equivalent, a spring.

XQ267. Now, please let us be clear about this. I suppose you will give your consent to the statement that a weight acts in a vertical line only?

A. The action of a weight is due of course to the action of gravity which is vertical, but such action may be diverted or directed in lines that are not necessarily vertical.

635 XQ268. Now please observe that we have assumed the walls of the record groove to be vertical; and in XQ254 we have assumed them to be "mathematically vertical."

How then, when a style bears by gravity upon the bottom of such groove is any component of the force of gravity diverted upon the walls?

636 A. Assuming the walls of the record groove to be vertical but of irregular form corresponding to sound waves, and the style resting in the bottom of the groove, and the machine in operation, the style must either yield to the undulations or to other irregularities in a groove which is not perfectly spiral, or deform the record, in which latter case intelligible reproduction would not be secured. With the parts properly constructed, proportioned and positioned, the style would yield to the irregularities whether those which correspond to sound waves or otherwise, and the readiness with which the same would yield would depend entirely upon the mass of the weight bearing upon the style or the tension of the spring. Before the style could thus yield the inertia of the style due to the spring or weight would have to be overcome, and this is overcome by the action of the walls of the record against the style, the pressure exerted between the two depending entirely, as I said before, upon the mass of the weight or tension of the spring.

XQ269. But the mass of the reproducer does not press upon the side walls by gravity, but reacts upon the same by inertia. Is this not so?

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A. Your question assumes that the weight is supported upon the bottom of the groove only, and with such an assumption of course the mass of the reproducer presses only upon the bottom, and undoubtedly the yielding pressure upon the side walls would be due to the inertia of the mass when a weight rather than a spring was employed.

XQ270. In your answer to XQ268, you spoke among other things of "the inertia of the style due to the spring or weight." Is it your understanding that a spring, or in fact anything else except mass, would give "*inertia*" to any body?

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A. Inertia, as I understand it, is the tendency which any body has to remain in the state in which it is or may be, whether of rest or of motion until caused to change that state by some outside power acting thereon. A spring bearing down upon a style would certainly have a tendency to hold the style in a certain position, the action of the spring in this case being exactly analogous to that of a weight, and I think very properly described by the expression inertia of the style.

XQ271. Now, under the conditions which we have assumed you say, if I understand you now correctly, that when the style is simply allowed to rest by gravity or spring pressure upon the bottom of the groove when the machine is not operated, it does not press by gravity or spring pressure upon the irregularities representing sound waves, but that as soon as the machine is operated the style does exert pressure upon such irregularities either by gravity, or by the reaction of inertia or by a spring. Did I correctly understand the position which you assumed?

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A. If the record groove have vertical walls with their regularities corresponding to sound waves thereon, and the style be assumed to rest upon the

640 bottom of the groove alone, then by the very terms of the assumption it does not rest upon the side walls. Even in this case, however, if the machine be operated the style will press against the irregularities in the side walls as stated in your question.

XQ272. And would it then reproduce sounds?

A. It would, yes, sir.

XQ273. It seems then that I have misunderstood what you said in answer to XQ265. You there said

641 "Assuming, however, that there is a record groove with vertical walls and with undulations in said walls corresponding to sound waves, and that it were possible to place a cylindrical style in said groove touching only the bottom of the groove and not the side walls thereof, and that the machine were operated, there would be no reproduction of sound."

Now, in your answer to XQ271 you have assumed the same conditions and you now say in your answer to XQ272 that under these conditions sound will be reproduced. It seems to me that these two statements contradict each other and if you can, please reconcile them.

642 A. The conditions in XQ265 and in my answer to XQ271 are not the same. In answer to XQ265 in that portion which you have quoted there was the express provision that the style did not touch the side walls of the groove and I there stated that in that case there would be no reproduction of sound and this is true. In XQ271 one of the express conditions was that as soon as the machine is operated the style does exert pressure upon the irregularities in the side walls of the groove. In answer to XQ272 I stated that in this case sound would be reproduced, and such is the case.

Counsel must understand that unless the irregularities corresponding to sound waves are brought into operative relation with the style of the re-

producer, that reproduction of sound is impossible. In answer to XQ265 it was expressly assumed that the style did not come into operative relation with such irregularities whereas in XQs271 272 it was assumed that it did. 643

XQ274. In other words you mean to say that when you made your answer to XQ265 you had in mind the condition whereby when the machine is operated the side walls of the groove would not come into contact with the style and you therefore say that under such conditions sound would not be reproduced. If you made that assumption in your answer to XQ265 I wish you would point out the language that conveys that idea. 644

A. That portion of my answer to XQ265 which you quoted in XQ273 expressly provides that the style does not touch the side walls of the groove.

XQ275. As I understand it, the language which I there find and which I have quoted in XQ273, says no more than that the style touched the bottom of the groove only and not the side walls thereof when it is placed into the groove, and says nothing and does not convey the idea that the style does not come into contact with the side walls when the machine is operated. However, we shall have to be content with your answer.

Now, under the conditions which we have so far assumed, when the style is placed into the groove touching the bottom thereof only, when the machine is not operated, it is not in contact with the elevations and depressions or other irregularities that correspond to sound waves, and I wish you now to state once and forever, so that there can be no mistake about it, whether under such conditions the style still bears upon the sound record with yielding pressure? 645

A. It does.

XQ276. Then please state what you meant by your answer to XQ264?

A. My answer to XQ264 is to be read in connec-

646 tion with my answer to XQ263 in which I stated that "If, however, the style bears in the groove which constitutes a sound record then it does bear upon a record. My answer to XQ264 simply went to the extent of saying that the idea sought to be conveyed by my previous answer did not go to the extent of saying that a style could bear with yielding pressure upon a sound record, even if it did not touch irregularities corresponding to sound waves. I simply had made no statement in regard to this matter one way or the other.

647 XQ277. But now you are willing to go to the full extent of saying that if a style of a reproducer bears upon the bottom of the groove although it does not touch the irregularities which represent sound waves, it still bears upon the sound record?

A. Certainly, I have heretofore repeatedly explained that the entire groove, side walls, bottom and all, constitutes the sound record, and when a style bears or rests upon this groove it rests upon the sound record. Assuming that the style bears upon the groove with a yielding pressure, then if the record tablet be revolved and the same be found warped from a true plane it will be found that the style will rise and fall in response to the warpings of the tablet and yet remain at all times
648 in contact with the record groove.

XQ278. In the machines described in patent No. 341,214 in suit you conceive then that the whole record groove constitutes the record, including the walls and the bottom?

A. The word record is to be interpreted according to the context and evident meaning or sense in which it was used, and whether the same is found in the patent or elsewhere.

For example the patent states that the invention consists in cutting or engraving the record in the form of a groove with sloping walls. Manifestly, the groove here constitutes what is meant

by the word "record." Lines 45 to 48, page 2. 649
the patent states that the depth to which the point
of the cutting style is embedded in the record
affects the amplitude of the style's vibration. By
"record" is here evidently meant the surface ma-
terial in which the style is acting. Claim 7 for
example is for "a sound record consisting of a
tablet or other solid body having its surface cut or
engraved with narrow lines" etc. Here it is very
evident that the word record is to be taken as in-
cluding the tablet and the line engraved thereon,
and this is the ordinary commercial acceptance of
the term. By the word "record" in line 77, page
1, I think the patent means the whole record
groove; by the word "record" line 47, page 2, I
think the patent means tablet surface; by the
word "record" as used in claim 7, I think it means
the tablet with the record groove engraved there-
in. 650

XQ279. The patent then is not drawn with such
accuracy as to enable one at all times to determine
exactly what it means when it uses the word
"record?"

A. I don't think anyone who was reading the
patent with the sincere desire to arrive at the
meaning sought to be conveyed by the patentees
would have any difficulty in understanding the
same. 651

XQ280. Would anybody have any difficulty in
understanding what the patent means when it
speaks of the "proper point" of the record?

A. I think not.

XQ281. Well, where would that proper point
be?

A. The "proper point" for the reproducing
style to touch the record in the act of reproduc-
tion is in the record groove, and each and every
point along the groove as the act of reproduction
proceeds.

XQ282. You make here no distinction, it

652 seems, between any lateral parts of the groove. Did you do this purposely, or is it your idea that a "proper point" of the record would be found on either of the walls or on the bottom of the groove indiscriminately?

A. My idea is that when a properly proportioned reproducing style is brought into proper operative relation with a record, that it will touch not only the bottom but the side walls of the groove as well. In order to bring it in position to thus bear upon the groove it is necessary to resort to very fine adjustment, laterally for example, and I think it is eminently proper when speaking of
653 such adjustment to refer to the style as being brought to the proper point on the record when it is brought into a position where it will touch the groove, side walls, bottom and all.

XQ283. You observe, however, do you not, that the patent makes provision for the style to gravitate to the bottom of the groove. Why then if any lateral point of the groove is a "proper point," does the patent make such provision!

A. I have not stated, and do not wish to be understood as stating that "any lateral point" is the "proper point," upon which the reproducing style should bear. The sound groove is an exceedingly fine hair like
654 line and to speak of the side wall of the groove as being one point and the bottom of the groove as being another point, while perhaps mathematically correct, is nevertheless a refinement in a case of this kind which I regard as unnecessary. In order that the style may bear in the record groove so as to touch not only the side walls, but the bottom thereof, it is necessary that the same should descend to the bottom of the groove. To accomplish this adjustment by hand would be an exceedingly delicate operation and the patent points out that by reason of the loose mounting of the reproducer no care is necessary to secure this adjust-

ment as the style will itself gravitate to the bottom of the groove.

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XQ284. You have not yet stated whether all lateral points of the groove are "proper points," and if so why the patent makes provision for the style to gravitate to the bottom of the groove?

A. I repeat that I do not recognize, except as a theoretical mathematical proposition, that there is such a thing as "lateral points" in the groove, and certainly no such suggestion is made in the patent itself.

XQ285. I understand that the patent speaks of the different parts of the groove by reference to its "sloping walls" and its "bottom." It seems then that the refinement which you say is unnecessary is made by the patent. Bearing this in mind and also bearing in mind that the patent speaks of the "proper point," which seems to imply an improper point or points, will you now please state why, if you consider every point of the record groove as a proper point, the patent makes special provision for the style to surely come in contact with a particular point, namely, the bottom.

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A. The portion of the patent which contains the expression "proper point" referred to in your question, is as follows:

"There exists always a liability to disarrangement in some part of the machine, either in the recorder or the support therefor, or the recording tablet or its support, or if there be no disarrangement it would be difficult to insure that the reproducing style should touch the record precisely at the proper point if the reproducer be held rigidly."

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Bearing in mind that the word "record" is frequently used in the sense of a tablet with a groove formed therein, it will be evident I think that when we undertake to place the reproducing style upon the record, that the "proper point" for the style would be in the groove and not between the

658 spirals of the groove. Having placed the style thus at the proper point it would be difficult to maintain it there during the operations of the machine if the reproducer were held rigidly. The reasons for this I have heretofore fully explained and it is unnecessary to repeat them. As I understand the clause quoted, then, it means that the style should be capable of movement toward and from, as well as parallel with the tablet in order that it might be brought into proper operative relation with the groove. The proper operative relation requires that the style should rest with its point in intimate contact with the surface of the groove, and the patent points out that the style will gravitate to the bottom of the groove, thereby coming into such proper operative relation.

659 XQ286. It is then your idea that the style is brought first, to the proper point by hand and is then allowed to reach proper operative relation automatically. Do I correctly understand you?

A. The style may be placed by hand in approximately the desired position upon the record tablet, after which by reason of its universal mounting, it will, when the tablet is revolved, automatically adjust itself into the record groove.

660 XQ287. Now, Mr. Cameron, the patent says expressly that by hand adjustment the reproducer style could not be brought to touch the record precisely at the proper point or could be made to do so only with difficulty, and in order to avoid this this difficulty it provides an automatic adjustment. Further that it is not every part of the groove that is considered by the patentees a proper point or place, is shown by the following passage:

"No special care is necessary to insure its adjustment for if the reproducer K be allowed to rest against the record with the style upon the engraved line, the style will of itself gravitate to the bottom of the groove."

You will see from this that the patent provides 661
that the style be placed by hand anywhere in the
groove and that it will then gravitate to the bot-
tom. Does it not seem from this that the patent
considers the bottom as the proper point and all
other parts of the groove as improper points?

A. I do not so regard it. The patent has in a
previous passage to that quoted in your question
indicated that one form of groove with which the
universally mounted reproducer might be employed
would be in the form of a groove with sloping walls
with undulations and depressions in the bot-
tom of the groove or otherwise, such undula-
tions and depressions representing sound waves. 662
In the passage which you have quoted to the effect
that the reproducing style would of itself gravi-
tate to the bottom of the groove, the patentees
evidently had in mind such a groove and simply
pointed out that the universal mounting afforded
a ready means whereby automatic adjustment of
the style in such groove might be secured; but it
certainly does not indicate that unless the style
is at all times bearing in the bottom of the groove
that it is not in a proper operative position. I
have heretofore pointed out that the record groove
as a matter of fact is frequently formed in the
shape of an arc in cross-section so that it would
be impossible to determine where the side walls 663
cease and the bottom began, or to say whether it
is all bottom or all walls.

In the groove of this form there are undulations
and depressions corresponding to sound waves and
such undulations and depressions extend entirely
across the groove, down one side to the other
thereof. Now the proper point upon the record,
meaning thereby the record tablet having the en-
graved line therein, would be with the style rest-
ing in this groove and as the point of the style is a
blunt rather than a geometrical point, it bears
upon the surface of the groove from one side to the

664 other thereof. This I regard as precisely the proper point for the style to touch the record. The automatic adjustment of the style to this point is due to the universal mounting of the reproducer. I regard the portions of the patent included between lines 58-84, page 4, as going to this extent and no farther.

665 XQ288. It seems to me that in an earlier part of your testimony, in your answer to XQ64, you found no difficulty in finding that the bottom of the groove was the proper place on the record, if the record be such as is described in the patent in review. How is it that you now experience such difficulty in admitting that the bottom of the groove is the proper place on the record?

A. I have not experienced any difficulty that I am aware of. I have explained what I regard as the meaning of the portion of the patent included between lines 50 to 84, page 4, and I do not think that such explanation in any way differs from that given in any other part of my deposition.

Adjourned to Tuesday, September 19th, 1899, at 10:30 A. M.

Washington, D. C.

September 19th, 1899.

10:30 A. M.

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Met pursuant to adjournment.

Present: Parties as before.

Mr. Lyons continues cross-examination of Mr. Cameron:

XQ289. Suppose a sound record to be made in the manner set forth in patent No. 341,214, in suit with the machine and the appliances there shown and described; and suppose that after it has been made, the bottom of the groove is scooped out by a chisel or other suitable tool so as to efface the elevations and depressions in the bottom; and now

suppose that the reproducing style be placed in such groove and allowed to gravitate to the bottom thereof. Would under such conditions the style bear with yielding pressure upon the record? 667

A. Under such conditions we would simply have a tablet with a groove formed therein without any irregularities corresponding to sound waves. We would not therefore have a sound record and of course if there was no sound record the style could not properly be said to rest upon the record at all.

XQ290. You seem to be mistaken or you have not understood my question. The question only assumes that the sound record is effaced from the bottom of the groove; and since according to your views the sound record is also found on the walls, there is still a sound record left somewhere in the groove although the point of the style does not touch it. Now, keeping this in view, state whether the style would bear upon the record with yielding pressure? 668

A. I have myself performed very nearly the experiment your question suggests. I have taken a sound record cut in a tablet of wax, or wax-like material in the form of a groove with sloping walls and have placed an ordinary recording instrument in the groove and operated the machine, after which the recorder was removed and a reproducer placed on the machine and the machine again operated. The result was that a reproduction was secured very much fainter than that which had been obtained before the recording style had been placed upon the record and the reproduction had frequent imperfections therein as might have been very reasonably expected. The reproducer, however, responded readily to the irregularities of the tablet other than those constituting the record and the fact that reproduction of sound was secured showed that the reproducing style was bearing 669

670 against their regularities representing sound waves. Judging from this experiment I should be inclined to think that under the conditions supposed by your question that the reproducing style might bear against the record provided, as I intimated in my answer to the last question, the entire record groove had not been so transformed as to make it simply a plane groove rather than a record groove. However, in hypothetical questions of this character and with such delicate operations as are involved in recording and reproducing sound, it is very difficult to state what would or would not occur in the absence of repeated and careful experiments under the conditions noted.

671 XQ291. In the experiment to which you refer when you operated the machine with the recording style in the groove you obtained sound reproduction?

A. I think so.

XQ292. This being the case the recording style was vibrated by the elevations and depressions as the same passed under the style, and consequently the bottom of the groove was not scooped out completely so as to efface these elevations and depressions. Is this not so?

672 A. In regard to that I am unable to state. The cutting style I remember removed a thin shaving during its action and that it did not wholly destroy the irregularities in the groove corresponding to sound waves is evidenced by the fact that some, though imperfect, reproduction was obtained subsequently by the action of the record in connection with the reproducer.

XQ293. It seems then that your experiment did not at all fulfil the conditions assumed in XQs289 and 290. The conditions there assumed are that the bottom of the groove be scooped out so as to entirely efface the elevations and depressions therefrom, but not to efface anything from the walls thereof; and that the reproducing style

which is then inserted gravitate to the bottom thus scooped out and effaced and not to touch the side walls which have not been scooped out and still retain such elevations and depressions as you say are ordinarily impressed upon them. Now, under such conditions would you say that the reproducing style bears with yielding pressure upon the record? 673

A. I should say that if the record groove had been so altered that it could no longer be utilized in the act of reproducing sound that it was no longer a record and if it was not a record a reproducing style bearing within the groove could not be properly said to bear against the record. If, however, the record groove were left in such a condition that it could be utilized in conjunction with a reproducer to reproduce sound, I should then say that such groove thus engraved in wax or wax-like material was a sound record and consequently that a style resting in said groove was bearing upon the record. 674

XQ294. Would under the conditions stated in the last question sound be reproduced?

A. In the first place the conditions defined in XQ293 are such as are wholly impossible in a practical sound record and any statement as to what would or would not occur would be purely a matter of theory which practical experiments might show to be erroneous. If, however, it is assumed that a reproducer can be placed in a minute hair like groove which has therein irregularities corresponding to sound waves, and the machine operated without the reproducer at any time coming in contact with such irregularities, it is evident that the reproducing style would not receive any movement due to the presence of such irregularities, and as the reproduction of sound in a sound record depends upon the co-operative contact of the reproducer with the irregularities representing sound waves, it would appear that there would be no 675

676 reproduction of sound due to such irregularities. As I stated in the beginning, however, the conditions assumed by your question are utterly impracticable and any statement as to what would or would not occur is purely theoretical.

677 XQ295. I now call your attention to your answer to Q5 and particularly to that part which appears in the last half of page 8 1-2 and the first part of page 9, of the typewritten record. You there say, if I understand you correctly, that the reproducer if it is so fixed that it cannot move toward and from the record will fail to reproduce if the tablet, being a flat disk, were warped even to the extent of a thousandth part of an inch. You there show quite conclusively that in such case the style would during some phases of the operation be entirely out of contact with the record and during other phases would dig into the record and iron it out. You even go so far as to say that mere changes of temperature would cause this result. Now, in your answer to XQ219, which is intended to be in reality an answer to XQ215, you could not make up your mind definitely whether the wobbling of the tablet to the extent of the maximum depth of the record would or would not cause reproduction to cease at certain moments altogether and be exceedingly imperfect at others.

678 Will you please state how it came about that you changed your mind?

A. What I did say in that part of my answer to Q5 to which you refer is as follows:

"It appears that Edison succeeded in actually obtaining reproductions of sound from his phonograph, but it was found impossible to use this tin-foil phonograph in practical affairs for the intelligible reproduction of speech.

Edison's reproducer was adjusted by the exercise of great care and skill into proper relation with the indented record and then clamped rigidly in position. As the groove

of the record is an exceedingly fine thread like line, this adjustment was very difficult to secure, and even when such adjustment was successfully accomplished, it was by no means certain that the proper relation between the style and record would be maintained. Inaccuracies in the construction of the machine, so minute in character that it is mechanically impossible to avoid them, would throw the record groove out of alignment with the style, or would cause the groove to approach too close to, or recede too far from the point of the style. For example, if the record tablet was a flat disk, any departure of the surface from a true plane, as by warping, even to the extent of a thousandth part of an inch, would cause the record to fail entirely to contact with the style, or else to bear upon it with such force as to iron out or deform the undulations. In fact, the finer and more delicate undulations were ironed out, even with the most accurate adjustments obtainable, but, while the larger undulations were so distorted that they no longer constituted even an approximate record of the original sounds. Of course when the style was thus in the act of ironing out an undulation, the latter was not causing the reproducing diaphragm to correctly copy the vibrations of the recording diaphragm and consequently the original sounds were not reproduced even the first time the record was used. I might add that the adjustment necessary to secure the proper contact between the style and the undulations or indentations was necessarily so accurate that variations of temperature alone were sufficient to throw Edison's rigidly clamped reproducer out of adjustment so that records made at one temperature could not be reproduced at another temperature."

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My answer to XQ215 and XQ219 went to the extent of stating that it was quite probable under certain combinations and conditions, depending upon the character of the record, the character of the diaphragm employed, the adjustment thereof

- 682 with relation to the record, and the direction which the tablet might take in its initial movement toward or from the style that reproductions would momentarily cease and at other times be imperfect, and that on the other hand with a different combination of these conditions it is quite probable that the reproduction would not be interrupted or very materially interfered with. I see nothing in these two answers involving any change of mind on my part, nor is there anything in one that is at all inconsistent with what is found in the other. It is true in regard to the Edison tin-foil record that when the record by reason of warping or other irregularities is withdrawn from the point of the rigidly mounted reproducing style so that it no longer contacted with the style, or when the record was bearing so hard against the style as to cause the latter to iron out the undulations, that the style could not be vibrating in imitation of the original sound waves, and consequently the original sounds were not reproduced. On the other hand, with a rigidly mounted reproducing style operating in conjunction with a "wabbling" record, it is very probable that there would be times when the reproductions would cease, and other times when the same would be quite imperfect. I, however, recognized the possibility of combinations of circumstances with a record of the character assumed in the series of cross-questions leading up to XQs215 and 219, that even with the wabblings or warpings of a disk, it is possible for the irregularities of the record to remain in operative contact with the style and therefore secure reproductions which were not materially imperfect.
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XQ296. You did not give, so far as I am aware, the combinations of circumstances, the possibility of which you recognized. Please give them now.

A. I did not have in mind any particular combination of circumstances, but simply recognized that it was possible that such might be formed.

XQ297. In your direct testimony in your answer to Q5 you are reported of having said among other things the following: 685

"The object of first loosely mounting the reproducer is not only to enable it to adjust itself to the irregularities of construction, which I have just mentioned, but is also *for the purpose of enabling the reproducer to be guided and moved by the record.*

This is found at the bottom of page 12 of the type-written copy of your testimony and the italics are yours.

Will you please point out from the specification of the patent here in review where it appears that the reproducer is to be *moved* by the record? 686

A. In that part of my answer to Q5 from which you have quoted and immediately succeeding the quotation in your question I quoted lines 68 to 84, page 4 of the patent where it is stated that the reproducer is mounted on a universal joint so that it can *move* in any direction, and that the *movement* parallel with the face of the tablet would by itself allow the reproducer to follow the record. I have repeatedly pointed out that this statement immediately follows a suggestion in the specification to the effect that there is always a liability to disarrangement in the machine whereby it is liable to fail to perform some of its proper functions, and that one of these liabilities of disarrangement lies in the fact that the machine might fail to advance the record in a right line past the style; and that in such case the portion of the specification which I have quoted in my answer to Q5 that the reproducer is mounted on a universal joint so that it can move in any direction, and further that even the lateral movement would enable it to follow the record. Should such disarrangement occur, in order that the style might follow the record, it would be necessary that it be moved thereby. Furthermore, it can be easily 687

688 demonstrated by observing the reproducer when in operation that the record does move the reproducer. The statements in the specification to which I have referred, therefore, coupled with my knowledge of the operations of the devices described by the patent when embodied in a practical machine, enabled me to state that the reproducer was mounted on a universal joint for the purpose among others of enabling it to be guided and moved by the record.

XQ298. In your direct testimony in your answer to Q10 you are reported on page 33 of the type-written record of having said as follows:

689 "And the specification further points out that there is a liability to disarrangement whereby the record will not have this movement and explains that in such or similar cases the capability of free lateral movement which the style has by reason of its loose mounting will enable it to *follow* the record as well as adjust itself thereto."

The "movement" which you refer to is the rectilinear movement of the tablet. Will you now please refer to that portion of the specification where it is pointed out that by reason of any disarrangement the record will not have or may not have the requisite rectilinear movement?

690 A. Immediately following that portion of my answer which you have quoted in your question I quoted lines 68 to 84, page 4 of the specification wherein it is pointed out that there exists always a liability to disarrangement in some part of the machine, mentioning among other examples that of the recording tablet or its support whereby it is rendered difficult to insure that the reproducing style should touch the record at precisely the proper point if the reproducer were rigidly mounted. Now, one of the disarrangements in connection with the support for the record might and sometimes does happen to be a failure on the

part of the machine to advance the tablet in a right line past the style, or what is an equivalent construction, to advance the style in a right line past the tablet. This failure of the machine to operate properly is, I think, fairly deducible from the statements contained in the lines to which I have referred, especially when read in connection with the further statement that the universal mounting for the reproducer, and especially its freedom of lateral movement, would allow the style to follow the record. It must be borne in mind that the interruptions to the rectilinear movement of the tablet need not necessarily be permanent or final, but merely intermittent interruptions immediately subsequent to which the rectilinear movement of the tablet or of the reproducer, as the case might be, might continue in the normal way.

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XQ299. The patent then does not *point out* that there are or may be failures or interruptions in the rectilinear movement of the tablet, but you *deduce* this liability in your own fashion.

A. The patent points out that there is a liability to disarrangements of a certain character from which anyone skilled in the art and familiar with the operation of such machines would readily perceive that interruptions to the rectilinear movement of the tablet might readily follow. The patent does not, however, in direct and specific terms, specify interruptions in the rectilinear movement of the tablet.

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XQ300. I suppose you have stated in an earlier part of your testimony that you never made a record in accordance with the disclosures which you find in the Cros French Patent to which you have referred. At any rate please state now whether you have ever made such record?

A. I never have.

XQ301. Do you know whether or not Mr. Cros ever made such a record?

A. I do not.

694 XQ302. Are you certain that it is possible to make an etched sound record in the manner set forth in the Cros Patent?

A. Never having myself made nor seen made a record in the manner set forth in the Cros Patent I would not state that I was perfectly certain that a record could be made in the manner indicated. But from my knowledge of the art and from statements to the effect that such records can and have been made by others who are well known experts in the art, I have no reason to doubt that records can be made in the manner indicated in the Cros Patent. For example, in the patent to Berliner, No. 382,790, I find the following claim:

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"1. The method or process of producing the record of sound waves in solid resisting material for reproduction of the recorded sounds, which consists in covering the surface of such material with a film of etching ground that offers no perceptible mechanical resistance, then making a phonautographic record upon and through the etching ground, and then exposing the record to the action of a suitable etching agent, substantially as described."

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In the body of the specification Mr. Berliner points out more in detail the method which he follows and which is included in the claim which I have just quoted, and this method is precisely the method described by Cros in his French patent.

It is fair to presume that a man of Mr. Berliner's scientific ability would not have taken out a patent for a method of making a sound record which was inoperative, and I therefore presume that he has made sound records according to the method set forth in his patent referred to.

XQ303. Probably he has; but what makes you certain that the method which Mr. Berliner practiced and which he described in his patent is pre-

cisely the method described by Cros in his French patent?

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A. The etching method described in Cros' French patent was one in which a metallic plate had placed upon its surface a thin coating of some material which would serve to insulate the plate from the etching action of an acid. He mentions tallow and paraffine as substances which will serve for this purpose. Having covered his metallic plate with a thin film of tallow or paraffine he then formed a phonautographic record therein after which the acid was allowed to eat or etch a line in the metal plate where the surface was exposed along the line of the phonautographic record.

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In his patent No. 382,790, Mr. Berliner states that in the course of his experiments he had found

"that in place of lamp-black other substances may be used as a non-resisting medium for receiving the original phonautographic record, and I have also found that among these substances are such as will resist the chemical action of acids, but which offer no perceptible mechanical resistance to the movement of the recording stylus. Upon this discovery my present invention is based, and it consists, broadly speaking, in producing a phonautographic record through a film of a suitable etching ground deposited upon a travelling surface of resisting material, such as metal or glass, and then subjecting said surface to the action of a suitable etching agent, which attacks said surface at the places only where the etching ground has been removed by the recording stylus.

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The etching ground which is to serve as the non-resisting medium for the phonautographic record, I prepare by dissolving beeswax, paraffine, or other like substance in a suitable solvent."

Cros after describing a phonautographic record traced in lamp-black, says:

700 "The lamp-black can be replaced by a body insulating an underlying metallic plate from the engraving action of an acid. In this case the work of the stylus is increased by the cohesion of the insulating substance. Tallow paraffine, the varnish of *aqua fortis*, can serve.

In this case an indentation is obtained which is only good for the repetition with a mouth piece, or with a solid point entering into the indentation and causing the sonorous body to vibrate."

701 Now the method of forming a thin film of insulating material upon a metallic surface for the purpose of forming or producing an etched engraving was a common and well known thing at the date of the Berliner Patent in question. Mr. Berliner therefore described in his patent simply a well known way of placing the identical insulating material mentioned by Cros upon the surface of a metallic place, forming a record in this material in the identical way described by Cros, and then etching by the means of acids such record in a metallic surface.

702 I am not unmindful of the statement contained in the Berliner Patent to the effect that the film upon the surface of the metallic plate offers no perceptible mechanical resistance to the movements of the recording stylus, nor am I unmindful of the statement in the Cros Patent to the effect that the work of the stylus when operating in the film insulating the metallic plate from the action of the acid is greater than when such stylus is operating in a lamp-black coating. In my opinion it is a matter of indifference as to which of these statements is correct, if in fact they are contradictory; the fact remains that both Cros and Berliner mentioned paraffine as the substance employed in forming the insulating coating for the metallic surface, and whether this substance does or does not offer greater resistance than lamp-black is to my mind

unimportant so far as determining the identity of the two methods described, the one by Cros and the other by Berliner. Cros certainly describes the method or process of producing a record of sound waves in solid resisting material, that is in a metallic plate; and that method consisted in covering the surface of the metallic plate with a film of etching ground which was of the identical material mentioned by Berliner as being employed by him in forming his film. Cros then made a phonautographic record upon and through the etching ground and then exposed the record to the action of a suitable etching agent, that is an acid.

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This is precisely the process defined by Claim 1 of Berliner's Patent No. 382,790.

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XQ304. Suppose it should appear that in the attempt of making a sound record in the manner suggested by Cros it is found that his layer of paraffine offers too great a resistance to the style to be penetrated by the same by the action of sound waves, and that the record can only be made successfully or at all when the etching ground is so exceedingly thin as to offer no perceptible mechanical resistance to the operation of the style. Would you then still say that the Cros method is identical with the Berliner method?

A. I should say that if one undertook to form a sound record through a film on the face of a metallic plate and found that the film was too thick that it was obviously a good idea to make the film thinner, and that the method of dissolving the insulating material and flowing it over a plate in order to procure a thin film on the plate (which is the method employed by Mr. Berliner to obtain a thin film) was a well known method of procuring just such a thin film for etching and other purposes. I should therefore say that when Mr. Berliner found that he needed a thinner film to carry out the Cros process than the one with which he, Berliner, had previously found to be too thick,

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706 that it was a perfectly obvious expedient to employ a thinner film and to obtain the thin film in a way at that time well known in the arts.

XQ305. Of course you would have no trouble of showing that it was old in the art to make an etching ground of beeswax or paraffine by dissolving these substances and flowing the solution over the plate. Please then point out such practice in the prior state of the art?

707 A. I have not the data at hand which would enable me to answer your question, nor am I able to answer it off-hand from memory. I think, however, that I am not mistaken in my statement that this was a well known expedient at the date of the Berliner Patent referred to.

XQ306. Did you ever learn that Messrs. Bell and Tainter have diligently attempted to make a Cros record and failed and gave it up in despair because they could not produce an etching film that offered no perceptible mechanical resistance to the action of the recording style, and at the same time protected the plate against the action of the etching fluid?

A. I never did.

XQ307. At any rate, so far as you are aware, an etched sound-record was actually made for the first time by Mr. Berliner?

708 A. I have no personal knowledge of any etched sound-record made either by Mr. Berliner or by anyone prior to Mr. Berliner.

XQ308. Have you ever seen an etched sound record?

A. I am not sure, but I think not.

XQ309. Your knowledge of etched sound records then is all derived from what you have read in the Cros Patent and in the Berliner Patents or have you any additional information on the subject?

A. I do not now recall anything that I have to offer beyond what is found in the Cros French patent and the art as the same is disclosed in U. S. patents to Berliner.

XQ310. This being the case, and not knowing anything yourself I suppose about the requirements of making an etched sound-record, what made you so confident to say in your direct testimony in answer to Q8?

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"From this it will be clear that in more than ten years prior to Berliner, Cros had told the world how to etch exactly this record in metal."

A. I have fully answered this question in reply to XQ303.

Adjourned to Wednesday, Sept. 20th, 1899, at 10.30 a. m.

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Washington, D. C., Sept. 20th, 1899, 10.39.

Met pursuant to adjournment

Present: Parties as before

Mr. Lyons continues cross-examination of Mr Cameron.

XQ311. In your direct testimony in answer to Q8, you are reported as saying that in Defendants' Machine the reproducing style completely fills the record groove and contacts at all times with the walls of the groove on both sides. You then add:

"The style does not move back and forth across the groove, but fits snugly therein so that the sloping walls of the groove act simultaneously on the opposite side of the style point and guide the same."

711

This is found on page 28 of the typewritten copy of the record, and you have elsewhere in your testimony said substantially the same thing. Will you now please state how you ascertained that the style fills the groove completely and does not move back and forth laterally within the groove?

A. I ascertained this fact by repeatedly and carefully inspecting the style when in the groove, using a microscope for that purpose. I took a

- 712 cross-section of one of complainant's sound records and placed the point of the style in each spiral of the groove one after the other and found that invariably the style filled the groove so as to contact with both side walls of the groove. Such contact with both sides walls of the groove would render it impossible for the style to have lateral movement across the groove. Of course I do not wish to be understood as meaning that the style did not follow the lateral sinuosities of the groove, but that it did not move within the groove, being prohibited from such movement within the groove by reason of the fact that it was held in contact simultaneously with the opposite sides of the groove.

713 XQ312. Can you give us an idea of the character of the microscope which you employed, and how you illuminated the cross-section of the groove with the style therein when you made your observations?

A. I used different microscopes and of various powers, and the light employed was both artificial and natural daylight, and direct as well as reflected.

- 714 XQ313. What magnifying powers did you use, and please also state whether the microscopes which you used were simple hand lenses or whether they were a combination of lenses mounted in a tube, and the latter mounted upon a stand for adjustment toward and from the object which you examined?

A. I employed both classes of microscopes to which you refer, the greater number of my observations and the greater portion of my work being done with high grade microscopes mounted on stands with tubes capable of adjustment as you have suggested in your question. Varying powers of lenses were used, and I think the greater portion of the work was done with lenses magnifying fourteen diameters and thirty diameters.

XQ314. What was the focal distance of any of these microscopes? 715

A. I am not an expert microscopist, and the greater portion of my observations were made with the assistance of one who is an expert microscopist. Such being the case I would not undertake to go into the minute and technical details in regard to the microscope and its operation.

XQ315. Did you, or did your expert assistant, mount the cross section of the record with the style therein; and did you or did your expert assistant, adjust the lenses for observation?

A. In some of the cases the expert assistant mounted the record and style into position for observation, and in others I myself placed the record and style under the microscope. The adjustment of the lenses so as to obtain the proper focus was one which I generally did for myself. 718

XQ316. In those cases when you mounted the cross-section of the record with the style therein, how did you hold the style in place in the groove?

A. There were a variety of ways in which the record was placed in position under the glass, if this is what counsel refers to by mounting. In some cases the record was placed flat upon the supporting table of the microscope and the style was allowed to rest thereon, the style being secured in the reproducer head of Complainant's Exhibit Defendant's Machine and the reproducer being carried by the universally jointed arm of such machine which arm was in position on the machine exactly as it is when in operation for reproducing, except that it was necessarily swung slightly to one side in order to place it in position on the record under the microscope. 717

XQ317. The cross-sectional plane of the record was therefore vertical?

A. In the instance which I have just described, yes, sir.

XQ318. And the style was mounted on the re-

718 producer head just as it is in the machine when the same is used for reproduction?

A. Yes, sir.

XQ319. How far back of the cross-sectional plane of the record tablet was the style in the groove?

A. The style was repeatedly examined, sometimes considerably removed from the cross-sectional plane and at other times was brought immediately up to the plane. I sought to observe the style in every possible relation and position in the groove.

719 XQ320. In this same experiment the tube of the microscope was then placed horizontally, was it not?

A. During the course of my studies observations were made with the tube of the microscope placed at a great many different angles to the plane of the records which we were examining. I would not undertake to say that it was placed exactly horizontal, but it was placed approximately so a good many times. It was also placed approximately vertical over the record and at numerous angles between the vertical and horizontal.

720 XQ321. You mean that in the case where you had the plane of the cross-section of the tablet vertical and the style resting in the groove in the manner you have described, you observed the object thus formed with the tube of the microscope at different angles, from approximately vertical to approximately horizontal?

A. Counsel must understand that the record was examined in a great many different positions and with the style in the groove at various points upon the record. Sometimes as I have stated immediately abutting the plane of section, and at other times so far removed from such plane that the section would not come within the field of vision. And furthermore, while I have mentioned the record as being in some instances mounted on the table of the microscope, it must be remembered

that it was also examined when it was not resting upon said table. 721

The record in various positions was observed with the tube of the microscope turned at various angles to the plane of the record, such angles as I remember extending sometimes towards the vertical and sometimes towards the horizontal. The various positions of the tablet and the various angles at which the tube of the microscope was placed with regard thereto, were resorted to for the purpose of viewing the style in the groove from every possible position. The one thing that impressed itself most upon my mind as the result of these observations was that the point of the style was always found to squarely fill the groove with the sides of the style contacting with the sides of the groove. 722

XQ322. When you here speak of the "plane of the record" you do not mean the cross-sectional plane, but mean, as I understand you, the plane of the surface of the record tablet. Am I correct?

A. You are.

XQ323. When you say that the style completely filled the record groove and contacted with the lateral walls, you do not thereby mean to say that it did not contact with the bottom, or do you mean to say that?

A. The groove is approximately V-shaped with a slightly rounded bottom. A style makes contact with the groove extending continuously down the wall of the groove on one side along the bottom and up the wall of the other side. 723

XQ324. Did it never occur to you that it was rather strange that a groove that is formed by the etching action of an acid, or is an exact reproduction of the same, should be fitted so nicely by a style that is made mechanically; the style being made perchance in England, and the groove being etched somewhere in the United States. And did it not occur to you that it was a strang coin-

724 cidence that the fitful and uncontrollable action of an etching fluid should accommodate itself so nicely to a form that is shaped mechanically by the hundred thousand or by the million?

A. It did not.

XQ325. Will you please point out that part of the drawing of patent to S. Tainter, No. 341,288 in suit, which illustrates best the construction defined by claim 44 of the said patent?

A. The construction defined by claim 44 of the patent referred to is best illustrated in Figs. 11, 12 and 15, sheet 5 of the drawings of that patent.

725 XQ326. Referring now to these figures of the drawings please state by what reference numeral the "flat metal spring" referred to in claim 44 is marked?

A. Reference numeral 359.

XQ327. This spring 359 is, as far as I can see, a flat spring fixed at one end to the body of the reproducer and extending radially darallel with the face of the diaphragm toward the center of the diaphragm.

Am I correct?

A. You are.

XQ328. What function does the patent ascribe to that spring 359?

726 A. It serves to hinge the style to the frame of the reproducer head.

XQ329. Now please point this out from the specification?

A. The specification states, commencing at line 66, page 6, that the reproducer has a style 357 fastened to the end of flexible strip 358 so as to project beyond both edges of the strip like a hammer head, the outer end of this style rubs over the recorded tablet and the inner end presses upon a flat spring 359 fastened at the lower end to the frame 350 of the reproducer. The strip 358 is soldered to the spring which by bending where it is attached to the frame 360 allows the style and strip

to be moved in or out and thus serves to hinge the same to the frame. 727

XQ330. It seems that you have not fully covered the function which the patentee ascribed to the spring 359. The patent says with respect to said spring.

"The diaphragm 362 of hard rubber about seven one-thousandths ($7/1000$) of an inch in thickness, is pressed against a conical seat in the face of the frame 360 by means of the spring 359, between which and said diaphragm is a little block 363 of cork. It serves the double function of pressing the diaphragm against its seat, and also of communicating vibrations to it." 728

This is found on page 6, lines 83-91 of the patent. I will now ask you whether the spring which you have found in complainant's Exhibit Defendants' Machine has the functions which are ascribed to the spring in the patent by the passage which I have quoted?

A. The sentence beginning line 89, page 6, which you have quoted in your question refers by the pronoun it at the beginning of the sentence to the block 353 of cork. It is the block of cork which serves the double function of pressing the diaphragm against its seat, and also of communicating vibrations to the diaphragm. Continuing the patent says: "Cork is used because it is light and conveys vibrations well." The patent further states that the cork can be secured by cement or otherwise in the position which the adjuster or maker of the instrument may determine. It is I think, however, undoubtedly true that the vibrations are conveyed from the style to the diaphragm not only through the cork but through the springs as well, and the spring acts through the cork to hold the diaphragm in position, as stated. In describing the modified form illustrated in Fig. 15 the patent describes the metal button 384 as being 729

730 used rather than the cork piece 363 of Fig. 11, and
says:

"This button bears upon the hard rubber diaphragm 362, and serves to communicate vibrations from the style to it." Lines 121-123, page 7.

The spring in Complainant's Exhibit Defendant's Machine has the function of conveying vibrations from the style to the diaphragm, but the diaphragm is clamped in the head independent of any holding action of the spring.

731 XQ331. And if this spring in Defendants' Machine has that function, then, of course, if this spring were cut away no vibrations could be transmitted to the diaphragm. Wouldn't this follow from what you have said?

A. The spring forms the support for the style and the means by which it is attached to the diaphragm head. If the spring were cut away it would of course carry with it the style.

XQ332. Of course you do not mean the style, you mean the style carrier?

732 A. In Defendants' Machine the immediate point constituting the style is fastened in a socket by means of a set screw which socket is supported on the frame or head of the reproducer by the spring, the spring being connected on the other side by means of a practically rigid connection with the diaphragm. It would of course be possible to cut the spring away from the reproducer head and also from the socket in which the style is attached, leaving the socket and rigid connection fastened to the diaphragm. I do not think, however, in this condition that such vibrations as occur in the practical reproduction of sound could be transmitted from the style to the diaphragm.

XQ333. Now suppose you did the same thing with spring 359 of the patent, would there still remain a rigid connection between the diaphragm and the style—or would not in that

case the diaphragm and the style tumble out of the apparatus, or if prevented from tumbling out by the guard 364, they would rattle about within the same? 733

A. I think the result in either construction, whether that of the patent as shown in Fig. 11, or in Fig. 15, or in Complainant's Exhibit Defendants' Machine, would be the same, viz., it would render the reproducer inoperative as a reproducer. In the absence of any clamping ring to hold the diaphragm in position in the head of the reproducer, the result would be to cause the diaphragm to be loose in its seat between the reproducer head and the guard 364. The only reason why the diaphragm in Complainant's Exhibit Defendants' Machine would not be loosened from its seat in the same way, is that a common and well known clamping plate is employed to hold it in position in the head of the reproducer. I do not, however, regard the presence or absence of this clamping plate as in any way affecting the principle of the construction defined in Claim 44 of Patent No. 341,288 in suit. Whether this clamping plate is present or not, Complainant's Exhibit Defendants' Machine shows the flat metal spring interposed between the style and diaphragm, and forming a yielding connection through which the reproduced vibrations are transmitted, said spring having a practically rigid connection with the diaphragm, as demanded by the terms of said claim. 734 735

XQ334. Now, Mr. Cameron, you have at one time in the course of your examination, said that you are not called upon and that it is not your function as a witness to save a claim. This being the case, please state whether in Defendant's Machine if the spring which you have therein discovered be cut in two, or cut away, there would not still remain a rigid connection between the diaphragm and the stylus, and whether the diaphragm would not still remain in its proper position just as before the spring was cut away?

736 A. The diaphragm would remain in its position without regard to whether the spring were or were not cut in two, because of the presence of the clamping plate which acts to hold the diaphragm in position. The style would be connected to the diaphragm if the spring were cut in two, but as I have before stated, I am of the opinion that this would render the device practically inoperative as a reproducer. Referring to Fig. 15, of the Patent No. 341,288 in suit, I would state that if the spring 359 were cut in two immediately below the part marked 383, that there would still remain a rigid connection between the style and the diaphragm in substantially the same way as there would remain a rigid connection between the style and the diaphragm in Complainant's Exhibit Defendants' Machine if the spring in that construction were cut in two. These are the facts of the case in the two constructions, though I am wholly unable to understand what possible connection such facts can have with my statement, that I do not feel called upon as an expert witness to save a claim. I regard it as my duty to state facts as I view them without regard to the effect upon a claim, one way or the other, and I wish once for all to state to counsel that while I am ready and willing to answer civil questions having legitimate bearing upon this case, that I do resent his continued intimations and insinuations as to my motives in making my answers.

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XQ335. If you cut away the spring 359 in the manner you have just stated, what will maintain the rigid connection between the style and the diaphragm?

A. Referring to Fig. 15, 384 is a metal button with the style soldered in a slit therein, the style being also connected by solder to the Spring 359 at the Point 383. The metal button may simply bear against the diaphragm under the influence of the Spring 359, the button being held in position by

friction, or it can be secured by cement or otherwise, as is clearly indicated in the patent when describing the use of the cork block rather than the metal button in the same position. With the metal button cemented to the diaphragm and the style soldered to the metal button, there would be precisely the same connection between the style and the diaphragm as is found in Complainant's Exhibit Defendants' Machine, that is, there would be a rigid part to which the diaphragm was secured, said part being cemented to the diaphragm.

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XQ336. But the metal button is not described in the patent as being cemented to the diaphragm and even if it were as you suggest that it might be, still the diaphragm, the remainder of the Spring 359, and the attached style would then, as one connected structure, tumble about. Is this not so?

740

A. The button in Fig. 15 corresponds to the cork block of Fig. 11, and the patent clearly states, in lines 97 to 100, page 6, that the cork block may be secured by cement or otherwise in position on the diaphragm. In the absence of any clamping means, and none such are shown, though it was a well known expedient, the diaphragm with the attached button, style and severed section of the spring 359, as one connected structure, would be loose in the diaphragm seat.

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XQ337. I suppose you have noticed that in case of the structure where a piece of cork is used instead of a metal button, the patent suggests that it may be secured by cement instead of being held by friction, because unless it be secured by cement or otherwise, it might not remain in the position to which it has been adjusted. Now in the case of the metal button, you must have observed that it is soldered and thus securely fastened to the spring 359 and to the thin metal plate 382 which constitutes the style. Does it not follow from this, first, that the patent does not say

742 that the cork piece is to be cemented to the diaphragm, but rather suggests that it be cemented to the spring 359, and, second, that there would be no sense at all in cementing the metal button to the diaphragm since it is already soldered in the position which has been selected for it?

743 A. I do not understand the specification as stating that the cork block is not cemented to the diaphragm. The patent clearly stating that it can be secured by cement or otherwise in the position which the maker or adjuster of the instrument may determine. It seems to me perfectly clear that when describing the modified construction shown in Fig. 15 in which the metal button is used, that the inventor did not feel called upon to again repeat the statement that the button which corresponds to the cork block of Fig. 11 could, if desired, be cemented to the diaphragm. Furthermore, I observe that claim 44 which undoubtedly is meant to define the construction shown in Figs. 11 and 15, states that the spring has a practically rigid connection with the diaphragm, thereby very clearly indicating that the spring is not only connected to the button, but that the latter is connected to the diaphragm the button thereby forming the "practically rigid connection."

744 XQ338 I suppose you will agree to the proposition that claim 44 is intended to cover also the construction where the little piece of cork is cemented neither to the diaphragm nor to the spring 359; and that consequently the "practically rigid connection" of claim 44 does not carry with it the idea that the cork is cemented to the diaphragm?

A. I should not regard the spring as connected to the diaphragm in the structure where a piece of cork is loosely interposed between said spring and diaphragm, and I should only regard claim 44 as referring to that construction wherein the cork block is used in case the cork block was cemented in position to the diaphragm and the spring as well.

XQ339. The spring 359 being parallel to the diaphragm would vibrate in the same plane as the diaphragm? 745

A. The spring can be bent or flexed independently of the diaphragm by reason of the fact that the style, especially in the construction shown in Fig. 11, bears upon the tongue of the spring beyond the block 363 of cork; and this construction is designed for the express purpose of giving the spring a movement independent of the diaphragm, thereby avoiding certain foreign vibrations which produce scratching noises in connection with the reproduction. I hardly think it is correct to state that the spring and the diaphragm vibrate in the same plane. 746

XQ340. Well, I suppose you have no doubt that the diaphragm vibrates in a direction at right angles to its plane, and that the spring also vibrates in a direction at right angles to the plane of the diaphragm?

A. The diaphragm undoubtedly vibrates in a direction at right angles to its plane, but whether the spring would vibrate at right angles to the plane of the diaphragm or not would depend upon the thickness and position of the cork block or the metal button. I think that the tongue of the spring as shown for example in Fig. 11 would vibrate in a direction which would possibly be not at right angles to the plane of the diaphragm. 747

XQ341. Please make this point clear if you can; and in your answer take note of the fact that the spring extends parallel with the diaphragm and radially across it. If you can, I wish you would explain in a manner that it may be understood by the Court, how it is possible that such a spring should vibrate in any direction different from one that is at right angles to the face of the diaphragm?

A. If the spring were exactly parallel to the face of the diaphragm, and if it vibrated as a whole

748 with equal amplitude in all its parts, then it would vibrate in a direction perpendicular to the face of the diaphragm. But the patent does not state that the spring is parallel to the face of the diaphragm, though apparently it is nearly so. The vibrations of the spring, however, are greatest in that portion of the spring, projecting beyond the cork block 363, and these vibrations would be toward and from the face of the diaphragm in a plane which is substantially perpendicular to the face of the diaphragm, but any single point of the spring would move on a line within such plane but not perpendicular to the face of the diaphragm
749 but substantially in an arc.

XQ342. It couldn't do this, could it, if the cork piece or the metal bottom were both soldered or cemented both to the diaphragm and to the spring?

A. I see no reason why it could not.

XQ343. Do you mean to say that the point of the spring to which the cork is cemented, the cork being also cemented to the diaphragm, could vibrate in any other path than the corresponding point to the diaphragm?

750 A. By observing Fig. 11 it will be seen that the cork is not cemented to the point of the spring, but that the spring is allowed to project some distance beyond the cork the latter being adjusted in order to get the proper length of the spring projecting beyond the cork, which is found best suited to absorb the vibrations which are thought to produce the scratchy noises in the reproduction. In the construction shown in Fig. 15, in which the metal button 384 is interposed between the strip 382 with which the style point is integral and the diaphragm, the same result is accomplished by reason of the length of the arm 382 which acts to absorb the foreign vibrations in the same manner as the tongue projecting beyond the cork, as shown in Fig. 11.

XQ344. From all that you have said in this respect, I suppose you mean to indicate that the spring 359 does not vibrate in a plane at right angles to the plane of the diaphragm, or does not altogether vibrate in such plane. Is this what you mean to convey?

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A. I have already stated in my answer to XQ241 that the vibrations of the spring would be toward and from the face of the diaphragm in a plane which is substantially perpendicular to the face of the diaphragm, but that any single point of the spring would move on a line within such plane, but not perpendicular to the face of the diaphragm.

XQ345. Now please state whether the spring which you have discovered in Complainant's Exhibit Defendants' Machine does or does not extend at right angles to the face of the diaphragm, and consequently if it vibrates, it must vibrate in a plane perpendicular to that in which the diaphragm vibrates?

752

A. I think your question states the position and plane of vibration of the spring correctly.

XQ346. The patent also says on page 6, lines 126 and 127, "It will be observed that the diaphragm is strained by the spring." Will you state whether the spring which you find in Defendants' Machine also strains the diaphragm?

A. I cannot state that it does.

753

XQ347. Suppose you substituted for the spring 359, a rigid metal bar. Would, under such conditions, the functions which are ascribed in the patent to the spring be performed?

A. I do not think that if the portion of the spring which projected beyond the cork block were absolutely rigid it would serve to absorb the foreign vibrations in the manner suggested in the patent. It would, however serve as a means through which the vibrations of the style could be transmitted to the diaphragm.

XQ348. Would it also hold the diaphragm in

754 its seat and would it strain the diaphragm and would it act as a hinge to the style?

A. With a cork block of the proper size it certainly might act to hold the diaphragm to its seat and to place a strain thereon. I do not think, however, that in the absence of any flexibility, it could be properly said to act as a hinge for the style.

XQ349. Suppose you did the same thing with Defendants' Machine, that is to say, that you made the structure of which you have spoken as a spring three or four times as thick as it is. Could it then be called a hinge?

755 A. If the part were left so that it had any flexibility, I think it would act as a hinge to connect the style with the reproducer head.

XQ350. I suppose you would call it a hinge even if it had only the millionth part of an inch flexibility?

A. The term hinge is used as indicating that it is a connection between the style and the reproducer head which permits the former to turn with reference to the latter. If the connection flexes so as to permit this movement, I should call it a hinge.

756 XQ351. Of course, you know that there is no such thing as an absolutely rigid body, and you would therefore call any structure, no matter how rigid, a spring or a hinge?

A. I would not.

XQ352. Where would you place the limit?

A. I would place it at the point where the connection failed to flex to any practical extent.

XQ352. And how would you determine the practical extent in such a structure as is shown in the patent in review or in such a structure as is represented by Defendants' Machine?

A. If it were such as to prevent the style from having any movement relative to or independent of the diaphragm I would call it a rigid connection.

but if it would flex sufficiently to allow the style to have any movements independent of the diaphragm or to absorb any of the vibrations of the style, I should regard it as flexing to a practical extent and sufficient to bring it within the scope of patent No. 341,288. 757

Adjourned to Thursday, September 21st, 1899, at 10.30 a. m.

Washington, D. C., Sept. 21st, 1899.

10.30 a. m.

Met pursuant to adjournment:

Present: Parties as before.

Mr. Lyons continues cross-examination of Mr. Cameron. 758

NQ353. From what you have so far said, as to the function of spring 359 in the reproducers shown in the Tainter Patent No. 341,288 in suit, it seems that the spring serves:

1st. As a hinge.

2d. As a means for pressing the diaphragm to its seat.

3d. For straining the diaphragm.

4th. For absorbing small vibrations and:

5th. For reducing the loudness but increasing the clearness of the reproduced sounds. Will you please state how many of these functions you are willing to ascribe to the structure in Defendants' machine to which you have referred as a spring? 759

A. The structure in Defendants' Machine to which I have referred as a spring, and which is a spring, is the piece attached to the circumference of the reproducer head by a screw, the said pieces being of metal about one-eighth of an inch thick at the point where the screw passes through the same and is then reduced to a very thin blade approximately about one-sixty-fourth of an inch thick beyond which it is again enlarged and has formed

760 therein the socket into which the style is secured by a suitable set screw. This thin blade portion which is, I say, about one sixty-fourth of an inch in thickness, constitutes the spring. This spring has the following functions, the same as does the spring in the Tainter Patent 341,288 in suit, viz.: it acts as a hinge; it will certainly tend to absorb small vibrations; and will thereby in the same manner as the spring of the Tainter Patent tend to reduce the loudness while possibly increasing the clearness of the reproduced sounds. As I have heretofore stated, it does not appear to act as a means for holding the diaphragm to its seat, the
761 diaphragm being clamped by suitable clamping plate. Whether or not it acts as means for straining the diaphragm will depend entirely upon the adjustment of the latter in connection with the rigid arm which extends from the spring and is connected directly to the diaphragm.

XQ354. In the Defendants' Machine the style holder is directly secured to the diaphragm. Is it not?

A. There is a substantial rigid connection between the style holder and the diaphragm.

XQ355. Is there anything intervening between the style holder and the diaphragm?

762 A. There is. The style holder, as I before stated, is in the form of a socket supported on the end of the spring which is screwed to the edge of the reproducer and said socket is connected by a suitable arm with the diaphragm.

XQ356. Please inspect more accurately Defendants' Machine and state whether it is not the fact that the style holder extends as a solid little rod from the center of the diaphragm, radially across the reproducer head, terminating a little distance beyond the edge of the same and there formed into a socket, said socket end passing through a little head or boss which has formed upon it, in one piece therewith, what you have called the spring, and a

set screw passing through the boss and socket for fastening a style in the socket. 763

A. I think you have stated the construction correctly. The fact, however, that the style holder and the rigid connection, as well as the spring supporting the same are formed integrally, does not deprive the spring of its function as a spring, the socket of its function as a style holder, nor the solid little rod of its function as a rigid connection between the spring and diaphragm.

XQ357. But since the style is fastened in the socket of the style holder, and since the style holder extends backwardly to the center of the diaphragm, and is directly connected thereto, how can you say that the spring is interposed between the style and diaphragm, and forms a yielding connection between the style and the diaphragm, as demanded by claim 44 of the patent here under consideration? 764

A. The difference between us is apparently a mere difference of words. The style is undoubtedly attached to a spring, which spring has a practically rigid connection with the diaphragm and is between the style and the diaphragm.

XQ358. Does the spring form a yielding connection between the style and the diaphragm as demanded by claim 44?

A. It certainly does. 765

XQ359. Then if you cut the spring away there would be no connection between the style and diaphragm?

A. That does not necessarily follow by any means.

XQ360. But if you cut away the spring in either of the forms of the reproducer shown in the Tainter patent, would there still be a connection between the style and the diaphragm?

A. There would. The wording of claim 44 of the Tainter patent, you will observe, does not define the spring as being connected to the style

766 and to the diaphragm. It merely forms a connection or support which would yield to the vibratory action of the style. Referring particularly to Fig. 15 of the Tainter Patent 341,288, it will be observed that if the spring 359 were cut off or broken at the point where the index leading from the numeral 359 touches the spring, that the style would nevertheless be connected to the diaphragm by the metal button 384, exactly as the style in Defendants' Machine would be connected to the diaphragm by the rigid arm which you term "a solid little rod," if the spring upon which the style socket is mounted were broken.

767 XQ361. You here assume, I suppose, that the metal button 384, is cemented to the diaphragm, and under this assumption, which is not predicated in the patent, you have said that when the spring is cut, the diaphragm and style and the remainder of the spring will be loose in the reproducer head and will rattle about in the same. Consequently may you say that there will still be a connection between the diaphragm and style when the spring is cut, then you assume that the metal button 384 is cemented to the diaphragm. Is this so?

768 A. I certainly regard the metal button 384 as being cemented or otherwise secured to the diaphragm, as the patent says the cork intervening between spring and the diaphragm may be, if preferred. I have heretofore pointed out that in the modified construction of Fig. 15 the metal button 384 is the equivalent of the cork block 363 of Fig. 11, which the patent expressly states may, if preferred, be secured by cement or otherwise.

XQ362. Now, Mr. Cameron, you have so far assumed that the spring 259 is cut at a certain point. Now assume that it is cut away entirely; every vestige of it is removed. Would then there still remain the connection between the diaphragm and the style?

A. In the form of the invention illustrated in

Fig. 15 of the Tainter Patent there would. The style would have an arm extending to and soldered fast to the button 384, which as I have before stated is cemented to the diaphragm. 769

XQ363. Then in that case, the diaphragm and the style would be loose in the reproducer head and if the latter be shaken by hand the two, if connected at all, will tumble about like a pea in a child's rattle. Is this not so?

A. The diaphragm would not be held to its seat by the spring of course, if the spring was removed; but in the act of reproduction with the weight of the reproducer head bearing down on the diaphragm and the point of the style directly in contact with the record, the diaphragm would not rattle around, as you express it, though I think its function as a reproducing diaphragm would probably be seriously injured, if not destroyed. 770

XQ364. You have not yet answered my question. Please state whether or not when the spring is removed, and the reproducer head is moved about, the diaphragm and style, if they should remain connected, would tumble about like a pea in a child's rattle?

A. The diaphragm would certainly be loose on its seat.

XQ365. The specification of Patent No. 341,214, is supposed, is it not, to express the understanding of C. A. Bell and S. Tainter of the apparatus there described? 771

A. I think it does.

XQ366. You have heretofore experienced some difficulty in admitting that the reproducing style shown and described in Patent 341,214 has a finer point than the recording style. Will you now please refer to Patent 341,288 in suit, page 6, line 72 to 75. You will there find the following:

"The outer end of this style (which should be somewhat more tapering at the point than the recording style) rides over the record or tablet."

772 And referring to page 8, lines 85 to 93 you will there find the following:

"Preferably the grooves are so close together that the ridge between them tapers to an edge on top, so that no matter where the reproducer may be placed the style will enter the groove, and being free to move sidewise will, owing to the sloping sides of the groove, penetrate to the bottom thereof under the action of gravity."

773 Does it not appear from this that Mr. S. Tainter certainly had the conception that the record groove was wider than the reproducing style, that the latter would slide down the sloping walls of the same and contact with the bottom of the groove, and being narrower than the groove, would not contact with the sloping walls?

774 A. The patent to Bell & Tainter 341,214, was filed June 27, 1885. The patent to Tainter 341,288 was filed some six months later. I have stated in connection with Patent 341,214 that it was not necessary that the reproducing style should have a finer point than the recording style. I have pointed out that in the record groove of the commercial records made under the Patent 341,214 in suit, the groove is in cross section substantially in the arc of a circle and that it varies greatly in width, the width in fact varying with the depressions and undulations representing the sound waves, and that the reproducing style or point is a substantially spherical one so that it contacts with the entire cross-section of the wall of the groove whether the same is narrow or wide. I have not stated however, that the reproducing style may not be finer at its point than the recording style, and in the particular construction described in the Tainter Patent 341,288, Mr. Tainter appears to have been of the opinion that the reproducing style should be somewhat more tapering at its point than the recording style. I

observed in the passage which you quoted from page 6, line 72 to 75, of the Tainter Patent 341,288, an expression which will assist in an understanding of the term "record" to which some of your previous questions refer. This quotation states that the style "rubs over the *record or table*," thereby very clearly indicating that Mr. Tainter recognized the tablet with a sound groove cut therein as being properly described by the word "record." Referring to that portion of the specification of the Tainter Patent 341,288 from which you quoted on page 8, and referring more especially to parts thereof immediately preceding and following your quotation, I find the following, lines 83 to 85, which immediately precede your quotation:

"It is then released, and the reproducer, falling forward, brings the style into contact with the record."

It then proceeds to state that the style will, in the preferable construction, enter a groove and² by reason of its freedom of lateral movement move down the sloping sides of the groove. The sentence immediately following that quoted in your question and commencing at line 93, on page 8 is as follows:

"The fly wheel being turned at about the speed used in recording, the reproducer *will follow the spiral groove* cut by the recorder, and will be acted upon by the inequalities or irregularities of the record and made to reproduce sounds or sonorous vibrations similar to those which acted upon the recorder to produce said inequalities or irregularities in the groove."

From this it will be apparent that Mr. Tainter recognized the fact that the reproducer will "follow the spiral groove," and this is doubtless the correct explanation of what was meant in Patent 341,214 in suit, by the expression "follow the

778 record," and not, as suggested in one of your previous questions that "by follow the record" is meant to slide down the wall of the record groove.

Furthermore, it has been suggested by some of your questions that the word "record" referred to the undulations and depressions or other irregularities cut by the recorder in the tablet and corresponding to the recorded sound waves. The sentence in the Tainter Patent 341,288 which I have last quoted, shows, I think, that Mr. Tainter regarded a sound record as a tablet with a groove formed therein having inequalities and irregularities and that when he used the word "record" that he referred to such tablet. I would particularly point out that Mr. Tainter speaks of the "inequalities or irregularities of the record, and not the inequalities or irregularities *constituting* the record. Furthermore, in lines 106 *et seq.* of page 8, I find the following:

"By these alternating movements, repeated for each ascent and descent in the record, and corresponding in extent and rapidity with the length and slope of the ascent and descent, the diaphragm is thrown into vibrations corresponding in form to the sonorous vibrations which caused the irregularities or inequalities."

780 It will be observed that Mr. Tainter here referred to the irregularities or inequalities as an ascent and descent, "*in* the record," thereby clearly indicating that he did not use the word "record" as meaning the ascent or descent themselves.

By counsel for Defendant:

Objection is hereby made to the foregoing answer of the witness as irresponsible, uncalled for and volunteered. There was nothing in the question that called upon the witness to explore the specification of Patent 341,288 in suit, with the view of de-

ducting therefrom an argument in support of some of his former contentions which, by the question to which he pretended to make answer were not called into question. By such and similar aberrations the witness has forced cross-examining counsel to prolong his examination to an undue extent; since counsel is forced to follow the lead of the witness into his ramblings in order that it may not appear that defendants are unwilling to consider every point raised by complainant's witness. The considerations which the witness has now seen fit to bring forward will oblige cross examining counsel to continue the cross-examination much longer than he intended. 781 782

In view of this, counsel for complainant is respectfully requested to instruct the witness to answer the questions which are propounded without deviating into other issues which have not been raised by any particular question.

Counsel for complainant considers that it would be improper for him to give any instructions to the witness whose entire examination shows that he thoroughly understands his duty to bring such facts and matters as lie within his knowledge and which are pertinent to the questions asked, to the attention of the Court. Counsel for complainant leaves it to the judgment of the Court whether the ramblings of this cross-examination are justly chargeable to the witness or to the cross-examining counsel. Touching the particular matter of the last answer, counsel for complainant submits that defendants' counsel has opened the door to an examination of the specification of 341,288 for such light as it may throw upon the subject matter of 341,214, and upon the precise meaning to be given to words found in the latter. 783

784 XQ367. Will you now please answer cross-question 366?

A. As I stated in my previous answer, it would appear from the passage which you quoted from 341,288, that Mr. Tainter was of the opinion that in the particular construction described in said patent, the reproducing style should be somewhat more tapering at its point than the recording style. It follows as a matter of course from this that the groove made by the recording style would in places at least, be wider than the reproducing style. The passage quoted also explicitly states that the style, owing to the sloping side walls of the groove, will penetrate to the bottom thereof, but I find absolutely nothing bearing out your suggestion that the style would not make contact with the sloping walls.

785 XQ368. Well, if the groove is wider than the reproducing style and the latter makes contact with the bottom of the groove; can it, at the same time make contact with the walls of the groove?

A. With a groove having sloping walls it certainly could, and in fact unless the style contacted with the walls of the groove it would, not, being loosely mounted, "follow the spiral groove" as stated in line 95, page 8 that it will do.

786 XQ369. Please make a sketch of a groove with sloping walls and show in your sketch inserted in the groove the reproducer style that is narrower than the groove and makes contact with the bottom of the groove, and explain with reference to that sketch how the style can at the same time make contact with the sloping walls of the groove?

A. I shall have to disclaim any qualifications as a draughtsman and decline to comply with the request contained in counsel's question, so far as making any sketches is concerned. However, if a sound groove be formed which in cross-section is substantially the arc of a circle, and a spherical reproducing style even though formed with a some

what smaller radius than that of the arc be placed in said groove and the machine operated, such style will contact with the surface of the groove, and as the groove advances and the style is guided by the groove as Patent 341,214 says it will be, or as it follows the groove as Patent 341,288 says it will do, it will necessarily contact with the sides of the grooves sometimes on one side, sometimes on the other. I have heretofore pointed out that while there is certainly a bottom to this groove (since it is not bottomless), and while it certainly has side walls, it will be impossible to state where the dividing line could be drawn so as to define the distinction between the bottom and the side walls. Nevertheless, a spherical reproducing point formed as I have heretofore stated in this answer would, as the groove travelled thereunder, continually contact with the bottom and the side walls thereof. By continually, I do not wish to be understood as stating that the point would be at all times and uninterruptedly contacting with both side walls and with the bottom, but that it would, as the groove continued to advance, always and of necessity be in contact with the bottom of the groove and one or the other sides thereof.

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By counsel for defense:

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All of that part of the foregoing answer which follows the first sentence thereof is objected to as irresponsible and purely volunteered.

XQ370. You are a solicitor of patents, you have a draughtsman in your employ and are in the habit of instructing him to make drawings and sketches for you. Will you not therefore be so kind as to have the sketch called for by the preceding question made by your draughtsman under your instructions?

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Counsel for complainant objects to the request as manifestly improper, inasmuch as the witness is here to answer questions and not to make sketches.

Counsel for defendant desires to be informed by counsel for complainant whether this witness is supposed to manifest this qualification as an expert by talk only; and whether he is to be exempted from any other manifestation of his qualifications as an expert.

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Counsel for complainant states that the witness has not been offered as an expert draughtsman, and further states that if defendant's counsel desires to use sketches in cross-examination, he shall have those sketches made himself.

Counsel for defendant replies that he is afraid that any sketch that he may produce will be found wanting in truthfulness of representation, by the witness.

Counsel for complainant states that he thinks it quite likely.

A. I will not.

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XQ371. Please refer again to the specification of Patent 341,288 in suit, and now particularly to page 6, and read from line 129 thereof to line 5, on page 7. Please state how much lateral movement would be allowed to the style under the construction there described?

A. I have no means of telling.

XQ372. How long do you estimate the length of the style proper, meaning the portion designated by the reference numeral 357 in Fig. 11. You will notice that one end of the style is in contact with the spring 359 and the other end of it projects through the guard 364 for contact with the record?

A. Without knowing the scale of the drawing of Fig. 11 it would be impossible to state the length of the style.

XQ373. Do you think the drawing in the patent copy which you have before you represents the reproducer much smaller than the commercial reproducer, and if so, about how much? 793

A. I have absolutely no means of knowing what size a commercial reproducer of the character illustrated in Fig. 11, would be. The reproducer illustrated in said figure is certainly much smaller than some reproducers that I have seen, but as reproducers vary in size, and I never saw one of the particular class illustrated in the figure, I am wholly without data upon which to base any reliable estimate.

XQ374. In your estimation could that style be much longer than a quarter of an inch? 794

A. I find nothing in the specification placing any limit in either direction upon the length of the style, the patent stating that in the "description of the machine shown in the drawings, dimensions, proportions, materials, and other details of construction are mentioned with particularity for the purpose of enabling others to make and use the new improvement, and not as limitations of said improvement, since it is obvious that modifications can be made in detail without departing from the spirit of the invention." I gather from the above that the style may be made of any length that may be found desirable or most expedient. 795

XQ375. Now, you are an expert in this art and you have before you the patent that describes with great minuteness of detail a complex structure. You have particularly before you Fig. 4, of the drawing of that patent which shows the relative sizes of the reproducer head and the record tablet. You also know the sizes of which record tablets and reproducers are made in practice. Now, will this not enable you to give the practical size of the style with an approximation of about one hundred per cent.?

A. It would not. In the first place, machines

796 and tablets have been and are made of a great variety of sizes. Reproducers have been like them, made both large and small. The character of the style, the diaphragm and of the head of the producer, would vary as they were used by one machine or another, and even on the same machine. Different characters of styles and diaphragms would be used for the reproductions of different classes of records. This being the fact, it would be impossible for me to state from the description of the drawing in the patent in suit, even approximately, what the length or the proportions of the recording style would be.

797 XQ376. Then please look at Fig. 11 of the drawing of this patent and state what the reference numeral 364 marked thereon indicates?

A. It indicates a rest which bears upon the record tablet when the reproducer is in position thereon.

XQ377. And there is a hole in that rest through which the point of the reproducing style projects. Is there not?

A. There is.

XQ378. And this hole is also shown in Fig. 12?

A. It is.

798 XQ379. Now, please state whether or not the extent of the lateral motion which the style can have is limited by the size of this hole?

A. The movements of the style relatively to the reproducer as a whole would be limited by the size of the opening in the rest 364.

XQ380. Is there any other free lateral movement of the style provided for in the patent, except such as is limited by the hole in the rest 364?

A. I understand there is. This patent describes an invention which is an improvement upon, or modification of, the construction shown in the Bell & Tainter Patent 341,214 in suit. That patent, as heretofore pointed out, loosely mounts the reproducer upon a universal joint whereby great free-

dom of lateral movement may be obtained. Patent 341,288, beginning at line, 134, page 2 states: 799

"Seventeenth. The record is not always perfectly true or straight—that is to say, the recording style not only moves lengthwise or at right angles to the recording surface, but has or is liable to have a side vibration which of course is recorded in the tablet. These side vibrations produce errors in reproducing unless means are provided for enabling the reproducing style to move sideways also. The mounting of the reproducer on a universal joint obviates the difficulty to a certain extent, but not altogether satisfactorily since the inertia due to the large mass of the reproducer is too great for it to respond as quickly as required. The difficulty is, in the present invention, overcome much more thoroughly by supporting the reproducing style so that it, or at least the end in contact with the record, can move sidewise independently of the diaphragm or other device upon which it impresses the vibrations. This freedom to move sideways can be secured by allowing the style to rock upon the end in contact with the diaphragm or other device behind, or by making the style in whole or in part of flexible material, or by mounting it on a flexible support, the flexibility of course being in the required direction." 800

I understand from this quotation that in addition to the freedom of lateral movement which may be secured by the universal joint construction of the Patent 341,214, there is provided in Patent 341,288, a more delicate mounting for the style, whereby it is enabled to respond to minute lateral vibrations which the inertia of the reproducer as a whole would prevent the style from responding to in case it were not delicately or freely mounted. I would not be understood as stating that the reproducer as a whole is specifically described as being mounted upon a universal joint in Patent 341,288. I understand, however, that it embodies improve- 801

802 ments upon the structure shown in patent 341,214 to Bell and Tainter, one of the leading features of which was the reproducer head as a whole mounted upon a universal joint, whereby it was enabled to follow the record, and I understand Mr. Tainter in Patent 341,288, as making additional provision for permitting the style to respond to more delicate side vibrations which the inertia of the universally mounted reproducer head would prevent it from responding to. In other words I understand Patent 341,288 as providing an additional freedom of lateral movement to the reproducing style over and above that provided in Patent 341,214.

803 XQ381. From the passages that you have quoted does it not appear that Mr. Tainter considered the universal joint for the reproducer as an unsatisfactory construction, and that he substitutes for the same, and not supplements the same, by making the style itself or the greater portion of it of flexible material. Does he not say expressly that by his invention the difficulty due to the fact that the record is not always perfectly true or straight, is overcome by his invention much more completely than they would be overcome by universally jointed reproducers?

804 A. He does not state that he substitutes the flexibly mounted style for the universally mounted one, nor does he state that he overcomes the difficulty in the present invention more thoroughly than is done by the universally mounted reproducing style. He does point out that even when the universally mounted reproducing style is employed that even then the difficulties due to the side vibration are not entirely overcome; that is, even when the universally mounted reproducer is employed there still remain difficulties to overcome, due to the inertia of the large mass of the reproducer, and that the difficulty is more thoroughly overcome by supporting the reproducing style so

that it can move sideways independent of the diaphragm. 805

XQ382. At any rate, you cannot find in this patent a universally mounted reproducer?

A. I find no specific statement in the patent to the effect that the reproducer is loosely mounted so as to have that freedom of lateral movement which is obtained in Patent 341,214 by the employment of a universal joint.

XQ383. Irrespective of any statement in the patent do, you find in the drawings and in the description any construction that could be called a universal joint for the reproducer as a whole?

A. The reproducer head is mounted upon the stem 365 shown in Fig 4, and this stem is connected to a carrier to which is attached the nut which engages the screw 334. The reproducer as a whole is described as being capable of movement around its axis toward and from the tablet when in position shown in Fig. 4. Any slight looseness of the mounting of the stem 365 in its carrier would endow the reproducer head with the loose mounting described in lines 84 to 86, page 1 of the Bell & Tainter Patent 341,214. It is impossible to state from the drawings whether or not the reproducer stem 365 is thus loosely mounted in its carrier, but as I have previously stated, my understanding is that this patent is meant to conform to the principles of the Bell & Tainter Patent 341,214, except in those features wherein it is specifically described as being modified. The patent expressly stated in line 91, page 9, that: 806 807

"The present invention is to be considered as an improvement upon or modification of what is shown and described"

in said Bell & Tainter Patent.

XQ384. Can you, or can you not, and will you, or will you not, state whether you find in this patent No. 341,288, a construction provided which

808 by any latitude of interpretation, can be construed to be a universal jointed reproducer?

A. I have already stated in my answer to XQ362 that I find no specific statement in the patent to the effect that the reproducer is loosely mounted so as to have that freedom of lateral movement which would be obtained by a universal joint; furthermore, I have stated in answer to XQ383 that it is impossible to state from the drawings whether or not the reproducer is thus loosely mounted. I have also given you my interpretation of the patent to the effect that I regard the Bell & Tainter Patent 341,288, as intended to embody the universally mounted, or at least loosely mounted reproducer of the Bell & Tainter Patent 341,214. I know of no way to make my meaning and my understanding of the patent clearer than I have done in my previous answers.

809 XQ385. Then you mean that it was the intention of Mr. Tainter to show a universally mounted reproducer but that somehow or other he forgot to show it since you cannot find it. Is this what you mean?

A. Not at all. I simply mean that Mr. Tainter shows and describes those particular features constituting his improvements and so much of the other parts of the machine as was necessary to enable such improvements as they were to be claimed to be understood, and that with references to such parts as he did not regard as of the essence of the inventive idea embodied in Patent 341,288, no pains was taken to specifically illustrate the same in detail.

810 XQ386. Can you now point out in the structure shown in this Patent 341,288 any provision for free lateral movement of the style in either direction that is greater than the radius of the little hole in the rest 364?

A. If the reproducer of Patent 341,288, is loosely mounted after the manner described in the Patent

to Bell & Tainter 341,214, then the style would have a lateral movement in either direction exceeding the radius of the circular opening in the rest 364. If the reproducer of Patent 341,288, is not thus loosely mounted, then the style would not have a lateral movement in either direction exceeding the radius in the small opening in the rest 364. I have already stated that Patent 341,288, does not specifically show or describe a reproducer thus loosely mounted. 811

XQ387. Will you please now measure the diameter of that little hole in the rest 364 as it appears in the copy of patent that you have before you, and give the size which you have thus determined in inch measure? 812

A. I have no instruments for making an accurate measurement of such opening, and if I had, such measurement would form no criterion to determine the size of such opening in either the original drawings, from which the patent was granted, nor of a machine constructed in accordance therewith.

XQ388. Why? Is it your idea that a machine constructed exactly in accordance with the dimensions shown in this patent office drawing would not work?

A. I have expressed no such idea.

XQ389. Then if the machine were constructed in accordance with the dimensions represented by the Patent Office drawings or by any copy thereof which you have before you, then the size of the little hole in the rest 364 would give us exactly the extent or free lateral movement of the style. Keeping this in view, please measure that hole, if you have an inch measure at hand or else estimate without measurement? 813

A. The Patent Office drawings I have not before me. The copy thereof is the official reproduction thereof on a reduced scale and any measurement from such copy would of course, fail to give the

814 measurements of the Patent Office drawings. Moreover, I have not at hand instruments of sufficient accuracy to make the measurements you desire, but would suggest that if counsel desires I will place my copy of the drawings at his disposal and he can make the measurements himself.

Adjourned to September 22d, 1899, at 10.30.

Washington, D. C., Sept. 22d, 1899, 10.30 A. M.

Met pursuant to adjournment.

Present: Parties as before and HORACE PETTIT, Esq., of counsel for defendants.

815 Mr. Pettit continues cross-examination of Mr. Cameron.

XQ390. As I understand your previous testimony, you are of the opinion that in a sound recording or reproducing machine any construction in which the style is capable of a yielding movement to and from the record tablet would constitute an infringement of one or more of the claims of patent No. 341,214. Is this correct?

816 A. The only claims of Patent No. 341,214, to which my attention has been directed, either in my direct or cross-examination, are 19, 20, 21, 22, 23, and 25. All of these refer to a reproducer, or a reproducing style. I observe that your question is not limited to a reproducing style. Claim 19 would not be infringed by a reproducing style in a sound recording and reproducing machine unless it was combined with a mounting therefor which would leave the style free to move laterally for automatic adjustment. Claim 20 would also require the style to be so mounted as to be free to move laterally for the same purpose, while claim 21 would not be infringed unless the loose mounting was secured by the employment of the universal joint. Claim 22 would likewise

require a loose mounting which would permit the style to move laterally, while claim 23 would require a universal joint. Claim 25 does not relate to the particular freedom of movement of the style referred to in the other claims. Those claims which I have mentioned as demanding a universal joint, viz.: 21 and 23, demand a construction which not only permits the style to move laterally but also be capable of moving toward and from the record, but I am not prepared to say that any construction that would permit the style to move toward and from the record would necessarily embody the universal joint demanded by these claims. If counsel will indicate the claims of the patent he has in mind and the construction capable of a yielding movement toward and from the record to which his question refers, I could more readily and satisfactorily answer the question.

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XQ391. You are certainly too familiar with all of the claims of Patent No. 341,214, or at least with the claims of that patent which have been considered so far in this suit, to require any designation on my part of particular claims relative to my question. Assuming that the construction referred to in my last question is incapable of lateral movement, what would be your answer?

A. If the reproducing style were mounted so that it was incapable of lateral movement it would not infringe claims 19, 20, 21, 22 nor 23.

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XQ392. This is your answer, assuming that the reproducing style referred to was capable of vertical movement, or movement toward and away from the record tablet. Is this correct?

A. Each of the claims mentioned would require a construction which would leave the reproducing style, either alone or in connection with the reproducer as a whole, freedom of lateral movement, and any reproducer which did not permit this would fail to comply with the requirements of the claims which I mentioned in my answer to XQ391,

820 and hence without regard to what the other features of construction might or might not be, a device which did not have this freedom of lateral movement would not infringe these claims.

XQ393. Assuming now that the construction referred to in XQ390 were capable of some lateral movement, what degree of lateral movement, in your opinion, would it have to be capable of, in order to bring it within the terms of any of the claims 19 to 23 inclusive?

821 A. It would be necessary for the style to have such freedom of lateral movement as would permit it to adjust itself automatically to a sound record in order to infringe claims 19, 20 or 22. Claims 21 and 23 call for a universal joint which would of necessity give considerable freedom of lateral movement. What the degree of lateral movement would be which would permit the style to automatically adjust itself to a sound record, that is, what the least movement which would permit this automatic adjustment to the record would be, depends entirely upon the character of the record. It might be very slight indeed.

822 XQ394. Then, as I understand you, as regards claims 19, 20 and 22, if the structure referred to were capable of lateral movement to the extent of the width of sound record, this would be sufficient to bring it within the terms of the said claims 19, 20 and 22. Is this correct?

A. That would depend upon the character of the sound record.

XQ395. Do you consider that the sound record is an element of these claims?

A. It is of 22 and 23. I do not regard it as an element of 19, 20 and 21.

XQ396. Your answer to XQ394 is: "That would depend upon the character of the sound record." What do you mean by "character" of the sound record?

A. I mean whether or not the record is one with

vertical or lateral or zig-zag irregularities; and in case it is either one of these, whether or not it is one of slight or of great irregularities corresponding to sound waves; and again whether or not it possesses any irregularities in its construction which are not due to or do not correspond to recorded sound waves, that is, such as might occur through failure of the machine to work with absolute accuracy for any cause.

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XQ397. If the structure referred to were capable of lateral movement to the extent of the width of a sound groove of the vertical type of sound record, what would be your answer as to the question of infringement of any of these claims?

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A. My answer would be that if the sound groove were perfectly true and regular, that a lateral movement which enabled it to move entirely across such groove would enable it to automatically adjust itself to such record groove, but if, on the other hand, the record groove had introduced into it lateral irregularities due to the failure of the machine to operate with perfect accuracy, that a lateral adjustment of the style which was equal only to the width of the record groove would not permit the style to follow the record, nor would it permit it to automatically adjust itself to the record at any particular point where it was desired to place it thereon. In this last case the style would not conform to the requirements of claims 19, 20 and 22.

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XQ398. Then, as I understand you, the structure referred to in which the style is capable of vertical movement or movements toward and from the record tablet, and capable of some lateral movement to the extent of the width of the groove of the sound record to which it is adapted, and which is operated by the machine, that this would be sufficient lateral movement to bring it within the terms of the claims, or some of them. Is this correct?

A. Any mounting for a reproducing style which

826 would leave that style free to have such lateral movement as would permit it to adjust itself automatically to a sound record, would infringe claim 19, whether such lateral movement were great or small and without reference to whether the style had freedom of movement toward and from the record or not; as I have heretofore stated in my testimony, claim 20 differs from 19 in that it calls for a reproducer which is so loosely mounted as to endow the reproducing style with a capability of lateral movement whereby it may automatically adjust itself on the record. Any construction of reproducer which leaves the mounting therefor
827 loose so that the style can have lateral movement and thereby adjust itself upon a record to any extent, would infringe claim 20 without regard to whether said reproducer has movement toward and from the record or not. Claims 21, 22 and 23 go to more specific combinations and hence I suppose are not included within your question.

XQ399. My question involves a construction in which the style is capable of yielding movement or movement toward and from the record tablet, and some lateral movement, will you therefore kindly continue your answer as regards claims 21, 22 and 23?

828 A. A reproducer which was capable of movement toward and from the record, and also had freedom of lateral movement even though such lateral movement was slight, might or might not be the equivalent of a universal joint, and so might or might not infringe claim 21. In regard to claim 22, any rubbing style of a reproducer so loosely mounted that it is free to have lateral movement sufficient to adjust itself to the record groove of a sound record, would infringe the claim when said style was acting in combination with a grooved tablet or other body having a sound record formed therein. In regard to claim 23, my reply is that a structure might have such freedom of lateral

movement combined with movement toward and from the record as to be the substantial equivalent of a universal joint mounting, and would therefore when co-operating with a tablet having a sound record formed therein as an irregular groove with sloping walls, infringe said claim 23. Whether or not such structure would be the equivalent of the universal joint could only be determined by more specific knowledge than is conveyed in your question. 829

XQ400. Do I understand you that the structure referred to capable of vertical and lateral movement toward and from and along the record tablet would not satisfy the term "universal" as employed in claims 21 and 23. Is this correct? 830

A. I certainly did not intend to give any such impression. A style which is capable of moving toward and from the record surface, and is also capable of moving parallel with the record surface, might and very probably would be the equivalent of a universally jointed mounting. I do not understand what is meant by movement "along" the record as employed in your question.

XQ401. I referred in using the word "along" to the lateral movement which we have been considering?

A. As your question included "lateral" movement as well as the movement "along" the record, I could not so understand it. But inasmuch it is to be read as the equivalent of lateral movement, that portion of my answer to XQ400 which refers to movement parallel with the record surface will apply thereto. 831

XQ402. In your answer to XQ399, first sentence, you have said that the structure referred to "might or might not infringe claim 21." Understanding the construction as you now do, what would be your answer to this portion?

A. I have no change to make in the first sentence of my answer to XQ399. I meant in that sentence

832 to convey the idea that without knowing all of the conditions surrounding a structure, that I could not undertake to give any hard and fast opinion as to whether or not it would infringe claim 21. I can conceive that there might be conditions wherein such a mounting would be an infringement because it would be substantially the equivalent of a universally jointed mounting; on the other hand I realized that there might be conditions unknown to me which would make such a structure a non-equivalent of a universally jointed mounting and in that case it would not of course infringe claim 21.

833 Cross-examination resumed by Mr. Lyons:

XQ403. In your answer to XQ369, although not called for, you referred to a record groove which in cross-section is substantially the arc of a circle and is in operative relation to the spherical reproducing style of smaller radius; and you said in this connection that such style would of necessity be in contact with the bottom of the groove and at the same time with one or the other sides thereof. Will you now please state whether it is, or is not, a true mathematical theorem that a circle of one diameter can touch a circle of another diameter at one point only?

834 A. At the same instant of time, yes, sir.

XQ404. Would it not follow from this that the spherical style which you have assumed could not at the same time be in contact with the bottom of the groove and also with one of the walls thereof?

A. With a perfect sphere as the style point, and with a sound groove whose cross-section was a perfect arc, it is true as a mathematical theorem that the style could touch the arc at but a single point at any given instant of time. With a groove of this character however, I leave it to counsel to state whether any given point in the arc can or

cannot at the same time constitute a point in the bottom and also the walls of the groove. 835

XQ405. Please refer to the patent of C. S. Tainter No. 375,579 in suit, and now particularly to claim 20 thereof, and state whether the rubbing point there described is not formed integral with the lever style?

A. The rubbing point constitutes the style, and in the particular embodiment of the invention shown in the patent such rubbing style is shown as being integral with the lever; but I do not regard it as necessarily so, as the patent states that it is obvious that modifications may be made without departing from the spirit of the invention. 836

XQ406. But the claim expressly demands, does it not, that the rubbing point be integral with the lever?

A. I should regard it as exceedingly narrow reading of the word "formed" found in line 3 of the claim to interpret it as meaning the same as "integral."

XQ407. Could you say that the rubbing point is "formed on" a lever if it is constructed independently of the lever, perchance in an entirely different shop?

A. I should read a statement found in the patent to the effect that a point is formed on a lever, in connection with the accompanying portions of the specification, bearing in mind the object sought to be accomplished by the construction defined. Reading claim 20, which states that the rubbing point is formed on one arm of the lever, which lever has the other arm connected to the diaphragm, the object being to enable the relative amplitudes of vibration of the point and the style to differ, I should have no hesitation in stating that a point which was first formed and then connected to the lever, whether removably connected or not, would be the mechanical equivalent of the point formed integrally with the lever. The function of the 837

arm, and the other arm connected to the diaphragm would fall within the language of claim 20, whether the rubbing point was integral with the lever or not. 841

XQ410. And this, no matter whether the amplitude of the diaphragm is increased or reduced with reference to that of the rubbing point?

A. Yes, sir.

XQ411. You have repeatedly referred to sound recording and reproducing machines that are in commercial use, and embody the inventions set forth in Patent 341,214 in suit. Will you please state whether in those machines with which you are familiar, the tablet is in the form of a disc as shown in the patent? 842

A. The sound recording and reproducing machines to which I have referred as being in "commercial use" have cylindrical tablets. There are, however, in commercial use to-day, machines employing the disc form of tablet, such as Defendants' Machine for example.

XQ412. Please disregard Defendants' Machine since the question whether the same embodies the inventions set forth in Patent 341,214 in suit, is a mooted one, as you are well aware.

Now with this understanding, please state whether the machines in commercial use have mechanism whereby the tablet is moved rectilinearly by a feed screw? 843

A. As a rule they do not, but they do have means for moving the reproducer or recorder rectilinearly past the tablet rather than the converse and equivalent construction of moving the tablet rectilinearly past the recorder or reproducer. The result in either of these forms of construction is the same, viz., the formation of a spiral groove on a flat disc or a helical groove upon a cylinder.

Counsel for Defendant: All after the first six words of the above answer is objected to as irresponsible and volunteered.

844 XQ413. In those machines in public use, the reproducer style has, as you said, a globular rubbing point. Is such globular rubbing point found on the reproducer style shown in the Patent 341,214?

A. No, sir.

XQ414. In those machines which are in commercial use, is there a style projecting beyond the edge or end of the instrument, so that the position of the point of the style on the record may readily be seen, as demanded by claim 25 of this patent?

A. No, sir.

XQ415. You have used this commercial machine which you have in mind quite frequently, have you not?

845 A. I have.

XQ416. Suppose now the construction of that machine were so changed as to agree more nearly with the construction shown in Patent 341,214, by mounting the cylinder that supports the cylindrical tablet upon a feed screw so as to give to the tablet the rectilinear movement, and doing away with the feed screw for the reproducer. If now with such a machine, which would certainly more nearly agree with the construction shown in the patent, you reproduced a record from one end of the cylindrical tablet to the other; and if you marked the position of the reproducer upon the frame of the machine at the beginning of the reproduction, and again mark its position at the end of the reproduction, how far apart would you expect to find these two marks?

846 A. There would be so many conditions that would enter into the construction and operation of the machine, that it would be difficult to answer your question definitely. The arm of the reproducer head may vary considerably in length, and hence the universal joint upon which the reproducer as a whole is mounted, may be at different distances from the point of the reproducing style, so that the movement on the universal joint, which

in the commercial machine is different with different reproducers and different machines, would vary greatly. Furthermore, I assume that your question contemplates a perfectly operating machine so that the record would be carried past the style with a smooth and uninterrupted movement. This, however, is liable not to be the case, and any failure of the record to advance with perfect smoothness and regularity would introduce still another condition into the problem. 847

XQ417. Let us then make the problem flexible by assuming that the machine is as bad as it can possibly be conceived. You may assume the feed screw to work as loose and as fitful as you choose, and all other things just as bad as they can possibly be to demand the greatest excess of lateral movement on the part of the style; but still the machine is to be operative enough to reproduce. Further assume such size of machine in actual commercial use as will require the greatest possible lateral movement of the style. Now with all this freedom of assumption could you not give, in inch measure the separation between the two marks which indicate the positions of the reproducer point with reference to the frame of the machine at the beginning and at the end of the reproduction respectively? 848

A. The worst assumption which I could make would be that the feed screw should fail to advance the record past the style, but should continue to revolve. In this case reproduction would continue within the limits of lateral movements of the style. The extent of this lateral movement would depend largely upon the length of the reproducer arm and the particular size of the machine in which it is employed, there being a number of styles and sizes of machines now upon the market. However, I think that even in this case the reproducer would continue to follow the record groove for a distance of from $3/4$ of an inch to an inch. In this case, 849

850 of course, reproduction would cease when the style reached the limit of its lateral movement, and whether the entire record would be reproduced or not would depend entirely upon whether the interruption in the feed of the record occurred near the end thereof or not.

851 XQ418. In your answers to XQ107, 108 and 109 you have spoken of your own experience with the machine in commercial use when the feed screw was thrown out of action. And you have there stated that the style in that case had a maximum lateral movement of $3/100$ of an inch on either side of its central position. How is it now that under like conditions you assume that the movement might be a whole inch, which makes it 33 times as large?

852 A. In my answer to XQ107 and succeeding questions I spoke of observations which I had made on a machine having a very short arm on the reproducer, this machine in fact being one of the cheapest and most compact machines put upon the market by complainant. I there stated that I had actually observed in the operation of such a machine the reproducer head with a capability of lateral movement equal to $6/100$ of an inch, that is $3/100$, on either side of the medial line, but I by no means undertook to state that with a longer arm or with a looser joint that such was the limit of lateral movement which the reproducing style could have under any and all conditions.

XQ419. You have stated in your testimony variously that in some reproducing machines there are found irregularities both in the machine proper and in the record groove and record tablet and in the mounting thereof; that the record groove may not be a true spiral or helix or it may be a spiral or helix of a different pitch from that of the feed screw; or the feed screw may fail to advance the record at times, or may not advance it regularly. You also said that the record may be warped or

eccentric and that for all these reasons combined or separately, there must be provided a free lateral movement for the style; and that in some cases this alone will not do but that there must be a universally jointed reproducer so that it may have not only lateral movement but also free movement towards and from the record. Have I correctly stated your position?

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A. I think you have.

XQ420. Supposing now that the feed screw were unfaillingly correct, that is to say, that it never failed to advance the record or the style (according to the construction employed) regularly; also suppose that there are absolutely no difference, between the pitch of the screw and the pitch of the record groove so that wherever the record groove changes in pitch, or deviates from a true spiral or helix the screw pitch would also deviate exactly the same amount. Suppose also that if the record is eccentric or is warped, the feed screw is similarly eccentric and has such bends or curves axially as correspond to the eccentricities and warpings of the tablet. Under such conditions would a universally mounted reproducer have any function?

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A. I cannot possibly conceive of the conditions assumed in your question as ever existing in an actual machine. What would or would not be the result upon the reproducer it would be impossible to say. Apparently it would eliminate from a machine many of the practical difficulties in the reproduction of sound records which are now so successfully overcome by the universally mounted reproducer.

855

Cross-examination closed.

SHELTON T. CAMERON.

Shelton T. Cameron

863 Reeve Lewis,
Notary Public,
District of Columbia.

It is hereby stipulated for the purposes of evidence in this case.

1. That the complainant is a corporation organized and existing as alleged in the bill of complaint.

2. That complainant's title to the several patents sued on may be proved by the introduction of certified copies of assignments to be received with the same force and effect as if the originals thereof were produced with due proof of execution and
867 delivery, subject to proper correction with the originals.

3. That complainant has complied with the requirements of law in respect of marking the articles manufactured by it with the dates of the patents covering the same.

4. That both parties may use in evidence uncertified office copies of U. S. Patents, and blue book copies of the specifications and drawings of British Patents, with the same force and effect as certified copies, subject to proper correction by comparison with the originals.

5. Both parties may use in evidence, without
868 formal proof, copies of any patents or publications appearing in the Court records of suits involving the patents here in suit, or any of them, subject to correction by either party.

Prima facie proofs closed.

Certificate of Magistrate waived.

REEVE LEWIS,
Notary Public,
District of Columbia.